NOTE ON IRRIGATION

IN THE

KOTAH STATE,

BY THE

CONSULTING ENGINEER FOR IRRIGATION IN RAJPUTANA.

1904.

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Map showing the chief Drainage Area in the State.

NOTE REGARDING IRRIGATION IN THE KOTAH STATE.

The Kotah State slopes northwards from the high tableland of Malwa, and is drained by the River Chambal with its tributaries, all flowing in a northerly or north-easterly direction. Of the tributaries of the Chambal within the State, the Kali Sind and its feeder the Parwan is the principal. It enters Kotah from the south, and joins the Chambal near the village Piparda.

The Parbati flows due north for 80 miles and falls into the Chambal, in the extreme north-eastern corner of the territory.

There are many small village tanks, and a few artificial tanks for Irrigation purposes have been made.

The area of the State is 5,684 square miles, *viz.* :—

Area of the old Kotah territories in *khalsa*...			3,114	square miles.
Do.	Kotries ..	... ...	381	do.
Do.	Muafi villages in jagir	...	844	do.
Do.	Shergarh division in khalsa	1,225	1,345	do.
Do.	do. in muaff and jagir	120		

The average height above the sea-level is about 900 feet.

The soil is generally *kali*, rich black, (2) *dhawni* of lighter colour, but prolific, (3) *lal pila* a yellow and red soil, (4) greyish mixed with kunkar.

Lands are classed of two kinds, *viz.* (1) "*chahi*" which produces opium and vegetables and (2) "*barani*" or depending upon the rain. The land tax on *chahi* is four times as much as on *barani*. The amount of *chahi* area is about 2 or 3 per cent. in each village, and is situated here and there near the different wells of the village. Thus well lands being limited and far apart, tank or canal water can only irrigate specified areas; where wells exist it is not urgently needed.

The cultivated area in khalsa of the old Kotah territories is 584,017 acres and of the kotries 140,925. In the Shergarh division it is 167,375 acres. The average cultivated area yearly in both *kharif* and *rabi* is 487,353 acres for the *khalsa* villages, so that the average cultivated area in each village is about 500 bighas.

The uncultivated area in *khalsa* culturable is 849,947 acres, and unculturable 574,429.

All classes depend for their existence on the produce of the soil. The black soil is naturally prolific and able to mature crops without watering, even in years of moderate rainfall. It is for this reason that famines have been almost unknown; the people generally had enough to live upon, and in ordinary years in some places there is difficulty even in getting the produce all removed.

The year Sumbat 1956 (A.D. 1899-1900) was, however, an exception ; and owing to the months of August and September being almost rainless, there was great distress, and 24 per cent. of the population at least perished. Opium and grain are the chief exports.

Poppy cultivation affords no protection against famine, but forms about 4 or 5 per cent. of the cultivated area in each village. It requires manure and watering every 8 or 10 days and much labour. For this reason the area cultivated is limited.

It would not do, therefore, to depend upon increased returns from opium cultivation in any Irrigation project. Tank or canal returns must be based on other crops.

The Kotah State has great facilities for Irrigation.

The whole country slopes towards the north and north-east. A range of rocky hills stretches across the State near the southern border, and several large rivers, which rise in the south, have forced their way through this range, and have formed comparatively narrow gorges, affording excellent sites for large Storage Reservoirs at the highest part of the State. The magnitude of these works makes one hesitate to recommend them until they have been properly surveyed and the projects have been drawn up and estimated, and until the necessity for them is proved.

There is good material at site also. Allusion will be made to some of these sites further on.

There are many good sites also for Storage Reservoirs of lesser size, all over the country, which from the uniform slope northwards lends itself to irrigation.

2. The late State Engineer, Mr. R. H. Tickell, has prepared a list of some 67 works for future consideration, involving an expenditure roughly estimated at Rs. 44,59,000.

The list is probably intended only to be suggestive, as it would take a thoroughly efficient staff some months, before even one of these large projects could be properly drawn up and estimated.

An efficient staff is certainly required to prepare and survey all those projects about which the Engineer Officer and the Revenue Department both approve. It will be a long time before they can be all prepared, and if the matter is not taken up in earnest they may not be ready when required or for years, and not only time but water will be lost every year to the State.

The Consulting Engineer cannot claim the same local knowledge as Mr. Tickell. He can only speak of the places he has seen. Many if not all of the works proposed by Mr. Tickell may be good project, but it would be advisable to have the plans and estimates prepared before a proper opinion can be given.

3. The population in 1891 was 719,061 (excluding the restored territory 526,267). In 1901 the population was 544,340, including the restored territory. The number of villages in the State is 2,804, of which 2,200 are *khalsa* and 604 are *jagir* and Udak villages.

4. The average Land Revenue is about Rs. 27 lakhs. In 1899-1900 (the famine year) it was about Rs. 12,15,000. The approximate revenue of the *jagir* and Udak villages is about Rs. 6 lakhs.

5. **Rainfall.**—The average annual rainfall is about 33 inches. It was deficient in most parts of the State in 1897-98, and particularly so in 1899. At Baran and Chipa Barod the rainfall in this year was not deficient much in total, but the rain fell mostly in July; August and September were almost rainless. If the State had been provided with large tanks to store the excessive rain of one month for use in the following dry months, crops could have been saved, which otherwise were certain to be lost.

6. **Rivers.**—Water flows more or less till March in the following rivers, and the approximate cold weather flow is stated to be as under:—

Parbati	...	... 100 c.ft. per second.	
Parwan	...	... 75	„ „
Ujar	...	... 15	„ „
Kali Sindh	...	... 125	„ „

A Map of the State is attached showing the different drainage areas.

7. **Submerged Weirs.**—There are said to be many places where small masonry weirs might be put across nullahs, to divert the water in the rains and afterwards to reserviors which exist, or might be made, within a reasonable distance.

Such places should be sought for and advantage taken of them, especially where there is rock in the bed, and stone therefore near at hand, and where the soil is favourable for Irrigation and people are ready and willing to make use of the water.

Another advantage which such weirs afford is to hold up a small supply of water, to benefit any wells at the sides or below, which supply water to fields on both sides.

It may be advisable to leave an opening or two in the weir, which can be used as a scouring sluice, and be closed by wooden planks in cut stone grooves when required.

Where such opportunities exist, success is assured and benefit is certain.

8. **Wells.**—There are said to be 12,688 wells in the State. The average depth of water in the inhabited parts of the State is only 20 to 40 ft. deep. In higher tracts the depth is greater and in some parts of Shahabad water is not obtainable in the hot season. Wells are said to have been made 100 ft. deep in the solid rock and have failed to reach water.

The lower portion is generally in rock. Well water is generally preferred to tank or canal water, and greater care and economy is exercised in using the water. An ordinary well will on an average irrigate about ½ to ¾ bigha in a day.

Owing to the nearness of water to the surface some officials consider it would be better to spend money in making wells than in making tanks.

It is undoubtedly a wise measure to make wells, when possible, below tanks.

In the *rabi* season wheat is watered once or twice, the average cost of watering a bigha for the season being 10 annas. Where there are wells, *kyaries* are used (small enclosure by earth raised at the edges). Opium requires 6 to 8 waterings, at intervals of 8 or 10 days.

9. Field embankments for retaining small quantities of water in suitable places are sometimes made, and in ordinary soil are beneficial, but are rare in black soil, which retains moisture better and has less need of such measures.

10. The Superintendent of Revenue states that the cutting back by ravines every year is becoming a cause of serious loss to the State. Petitions are received every year to have land which has been thus damaged struck off; and every year about 500 bighas or so, it is said, have to be written off. He asks how this loss is to be averted?

This loss does not occur in Kotah only, but everywhere near any river or nullah with deep banks.

It is not an easy question to answer, because the areas affected are often so great that the expense would be prohibitive. The damage always occurs where surface water collects, and in its onward course meets with a sudden drop. The earthen edge cannot resist the falling water and gradually is cut back.

One way is to divert the surface water elsewhere, or over a place where it cannot cut back, natural or artificial; or to store it somewhere, so that it shall be water at rest.

In small cases it may be possible sometimes to put an earthen bund across the ravine or depression, and if the basin so formed is large enough to contain all the water it will gradually soak into the ground and the earth gradually silt up the hollow; and if it is not too deep, it will in time form a fertile depression.

11. Irrigation throughout the State is chiefly from wells. It has been attempted from tanks, from rivers and by canals, in a few places; but these have not hitherto been always a success.

Tank or canal Irrigation seems to answer better where there is not black soil. In places where the soil is poorer, or mixed with sand, water seems to be appreciated, and there is a good return.

It would be advisable to have those tracts marked with colour on the map, and to direct attention to those tracts first.

The Raj does not take increased land-tax but only the water rate at present, though land which can be irrigated by tank or canal will no doubt be assessed higher, when a new assessment is possible.

That water does produce benefit is proved by the fact stated, *viz.*, that the black soil without water will produce about 4 maunds, but with water about 5½ maunds. The "pila" soil without water is said to yield from 2 to 3 maunds, with water it often reaches 7½ maunds. If these statements are correct, it shows the advantage of supplying water to this sort of soil in preference to the black soil.

The Superintendent of Revenue suggests efforts should be made to promote irrigation in Kishenganj, Bhorgarh and Shahabad, on account of the great scarcity of water in the hot season, when wells run dry and drinking water is difficult to obtain. The tract is practically without population. The Durbar is offering it on Zemindari terms to foreigners, but before people will settle, water must be provided to last throughout the year.

The Superintendent of Revenue also states that tanks which have been made in some places in the "Uparaite" (or high land of the Shahabad Tehsil) on the nullahs, have not retained water, probably owing to the nature of the rock, and suggests that storage tanks be made on places between the nullahs, where the rocky ground is covered with a layer of better soil, and that water from the nearest nullahs should be diverted to such places, believing that there will then be hope of retaining the water. The experiment might be tried.

Another factor which affects irrigation is that a great part of the State is black soil, which if broken up to receive the rain, retains moisture longer than lighter soils; so much so, that large areas are sown with "katha" wheat, and if the rainfall is timely the crop requires no further watering, the only labour then required being to guard the field. The ease with which such vast areas of wheat are matured, in years of average rainfall, no doubt tends to make the people in such localities indifferent to irrigation and averse to labour, as not worth the extra trouble. Excessive rain, it is said, damages the crop, and the only time that water would be appreciated is in years when the rain holds off at the latter part of the season.

In the southern portion of the State wheat is said to be of three kinds, "katha," "pisey" and "mugsi," in the other parts "katha" and "baja." The peculiarity of the "katha" is that it can be matured on the rich black soil without watering, timely rain is all that is necessary; and though the yield is not so great per bigha, the rate with which it is obtained makes it more popular with the people than other kinds of wheat.

12. Irrigation is said to be appreciated where it has been tried in the poorer soils. Instances are given at Myara on the Parbati Canal, and at Rani Barod below Aklera, where in both places the villagers refused to take the water at first, but are now eager to get it, showing that the desire for it grows with experience.

13. In some parts of the State (for instanee in the Kailwara distriet), although several bunds have been made, it is said in many the water dries up after the cold weather; this perhaps is due to fissures in the rock, in the nullah beds or in the substratum. This is a danger which will have to be borne in mind in taking up projects in such places.

If it is not possible to make use of the leakage, it may be better to divert the water from the nullah to some place on the open country, where it ean be stored without fear of rapidly disappearing.

14. Full use is not made of the large quantities of water whieh flows in the rivers during and after the rains, nor in some plaees of water whieh has been stored.

It would be advisable in every ease of this sort to ascertain from the villagers themselves the reason of this, and might be possible then to provide a remedy.

The reasons generally stated by the officials are—

(1) That the villagers want the water for their eattle, as by pereolation it benefits their wells, and so they do not like to use up the tank water.

(2) That the tanks are not large enough to supply water for the above and for irrigation.

(3) That the soil, if black, does well enough in ordinary years without irrigation.

(4) The fear that if the land is watered, the Raj will increase the *lagan* or land-tax; how far this is justified it is difficult to find out.

15. It might be possible to increase the capacity of some of the tanks by raising the bund, or by having shutters fitted to the eseapes, which could be closed at the end of the rains. If the tanks do not fill in ordinary years, to increase the eatchment by cutting surface drains, to enclose a larger area, or by diverting a nullah above, if possible.

16. Village tanks sometimes suffer from want of proper escapes, or from the bank not being kept up to its proper section or height.

If all the Khalsa tanks were brought on a register and properly cared for, this would be prevented. The appointment of an offieial under the Engineer Officer, to see to such matters, is suggested.

Some tanks have been made or repaired more for village purposes than for Irrigation. Money thus laid out for the public good is money well spent, but should not be ineluded in the amount spent on Irrigation.

17. The late State Engineer, Mr. R. H. Tiekell, in his printed Report alludes to existing old tanks, and says: "Revenue officials are in the habit of forming their opinions on the value of tank irrigation from a eonsideration of these old-fashioned and obsolete ponds, and they argue that as the Kotah State possesses say 350 ancient tanks from which say a total of 4,227 bighas only are irrigated, tank irrigation is not suited to Kotah.

The fact is that no tank is worth calling an "Irrigation work" that does not contain 25 m. c. ft.; perhaps 50 m. c. ft. should be the lowest limit. Of tanks of 50 m. c. ft. or more, the Kotah State only possesses four ancient tanks; one modern tank and six more are now in course of construction."

18. To be an efficient Protective work against Famine, a large area should be commanded, an unfailing and unlimited supply of water should be available at the proper time, good land available to irrigate and people able and willing to take the water.

19. There does not appear to be any fixed amount set apart annually for Irrigation; the progress of Irrigation therefore depends mainly upon the amount which can be spared annually. This is a weak point. If it is desired to push on Irrigation properly I would suggest that a systematic policy be adopted—

(1) For the preparation of projects. These should be properly prepared and the plans and estimates be placed on record.

(2) Permanent Bench marks should be made at site, so as to avoid the necessity of having to re-survey any project; and to enable any work to be taken up at any time by any one.

The above does not require a large outlay, it is the first step, and is necessary in any case, whatever course is adopted afterwards. It enables the Raj to compare the projects proposed and to select the best to be taken up first; and it enables work to be started in time of need without loss of time or wasteful expenditure, which is too likely to occur if such foresight is not adopted.

As regards the carrying out of Irrigation work—

(1) To fix as large a grant as the State can afford—one-tenth of the revenues is not a large share for so deserving a purpose—and to set this apart for Irrigation annually. The money is all spent among the people; it is sure to benefit them in their way, and if properly spent is sure to be returned in one way or another to the Raj.

(2) To get the opinion of the Revenue officials as to the respective merits of each project from their point of view, and when the Durbar has approved certain projects to the amount proposed, then to go ahead vigorously.

Irrigation takes time to develop, and should not be attempted in a half-hearted way. It is only when a work is completed that any profit can be realised, or any return can be expected on any portion of the money laid out.

When the Engineer knows the amount to be sanctioned, he can arrange to keep up an efficient staff, and to push on work accordingly.

20. The State Engineer and the Superintendent of Revenue have prepared a list of many good projects.

It merely now rests with the Durbar to order the plans and estimates of such of these as are approved to be prepared. This is the first step.

When some of these are ready it will be time to consider the ways and means of carrying out those that meet approval.

21. In this State, the Supervisor who carried out many of the existing works, Babu Govind Pershad, was appointed Superintendent of Revenue in A.D. 1894. He has always taken a keen interest in Irrigation, and has done all in his power to ensure the progress of Irrigation.

That such efforts are necessary is proved by the fact that after taking charge in one instance (again) in one year he states: "The tank was made in 1890 and approximately it has irrigated 50 bighas of land yearly, and still irrigates the same amount. It was only in 1897-98 that the Zemindars under my special orders, with great reluctance, irrigated about 800 bighas of land from the tank water," and the total revenue has been raised from Rs. 5,000 to Rs. 20,000; and he hopes in time to double it.

The memorandum he has prepared on Irrigation gives the result of his experience and is deserving of record. It is alluded to in para. 23.

22. The Report prepared by Mr. R. H. Tickell, late State Engineer, "on the Irrigation works of the Kotah State for the year ending 31st December 1900, with suggestions for future Irrigation works, as an Insurance against Famine," which was printed and presented to the Irrigation Commission, is a valuable contribution to the subject. But the details as regards future Irrigation works appear to be founded on insufficient data, and it was probably only intended to be suggestive. The Consulting Engineer does not think any of these works should be carried out until proper plans and estimates have been prepared and the opinions of the present State Engineer, Mr. Devon, and the Revenue Department and the villagers concerned, have been recorded.

A copy of letter No. 134, dated 16th September 1901, from the Diwan of the Kotah State to the Political Agent, (see Appendix No. I.), clearly expresses the views of the Durbar regarding the Irrigation Projects proposed by the late State Engineer, Mr. R. H. Tickell.

In his evidence before the Irrigation Commission, Mr. Tickell himself recommends the works he proposed should be taken up gradually, as the State would then be able to see, as it goes on constructing, whether the works are profitable or not.

23. A summary of the opinions expressed by the Revenue Superintendent of the Kotah State on this Report are recorded below.

He has had 26 years' of experience in works connected with Irrigation —12 in the Jaipur State and 14 in the Kotah State—and most of the Irrigation works constructed by the late Mr. Miles were carried out under his supervision; and for the last 9 years he has been Superintendent of Revenue in the Kotah State.

The opinions expressed by a man of such experience, the Consulting Engineer thinks, are deserving of consideration. For this reason the following brief summary of his opinions is submitted. He says: "The late State Engineer proposes to enlarge seven works which are in course of

construction, and recommends 67 new works (*vide* Appendix E. of his Report) at a cost of Rs. 4,459,000, which he alleges will give an increase of revenue of Rs. 5,14,000, or in other words about 11 per cent., and recommends the undertaking of the works even on funds obtained by loans."

The Revenue Superintendent regrets that his experience of the Irrigation and Revenue Departments does not permit him to agree with the above. Although water may be stored in reservoirs, in the Kotah State experience proves it is not used to the same extent as in other places, and he compares Kotah and Jaipur States.

In the Jaipur State.	*In the Kotah State.*
(1) All land requires irrigation and yields a good return.	(1) Generally land does not require irrigation (because of the rich black soil), except in places where the soil is poorer. In rich soil crops are said to be spoiled by excessive rain.
(2) Wheat does not grow without irrigation.	(2) Wheat generally is grown without irrigation, but wheat if sown on poorer soil if irrigated produces a better crop.
(3) The average rent per bigha of unirrigated land is Re. 1, while irrigated wheat land produces about Rs. 4, exclusive of water-tax 8 annas.	(3) Land revenue of irrigated and unirrigated land is Rs. 1-4-0 per bigha. In the case of irrigated land an additional water-tax of As. 0-10-0 per bigha is charged.
(4) Poppy cultivation is very limited, and wheat cultivation is preferred.	(4) Poppy is generally cultivated in every village, in the proportion of 4 or 5 bighas in every 100 cultivated bighas. The cultivators think well water more suitable for opium; 40 or 50 bighas is the average in each average-sized village.

(3) The soil is generally black cotton, which is said to retain the moisture better for this reason: chiefly *rabi* and *kharif* crops here do not require irrigation. Excessive rainfall causes blight and does harm. In a few places where the soil is poorer irrigation is desired. Irrigation in the Kotah State, generally speaking, is limited to poppy cultivation and is watered from wells. This is called "Piwat," and does not exceed 5 per cent. of the total cultivated area.

(4) If water is stored in reservoirs for irrigation in any village, only such lands as are under poppy would require water, the remaining water too often remains unused.

(5) Storing water will not necessarily increase cultivation. The Iklera Tank is given as an example. During the course of 15 years neither the Raj revenue nor cultivation has increased.

(6) Storing water it is true is generally considered a protection against famine, but in the Kotah State a small (if timely) rainfall gives a good return, while excessive rainfall proves injurious. This is the cause why famine has been seldom known in Kotah, and the same necessity for protective measures do not exist as elsewhere.

(7) As the soil only requires a small quantity of water, the zamindars trust to getting all that they require in the rains, and do not apparently care to take water from tanks, even if available.

In 1900, although water was available and the water rate is low, they trusted to the rains, and half the *kharif* crops withered.

(8) As regards the Parbati Canal only 17 per cent. of the cultivated area is irrigated by the canal and its branches.

This is given as proof that the soil is not suitable for irrigation; originally the canal was dug to a length of 17 miles only, but when it was found that only 3,500 bighas were irrigated, the length was increased to 45 miles; and the distributaries to 150 miles to reach more suitable soil.

The average area irrigated during the last 6 years is 16,137 bighas.

If the canal discharges, as Mr. Tickell states, 150 c.ft. per second, this gives approximately a duty of 47·8 acres per cusec.*

It is possible, the Consulting Engineer thinks, that the water is not delivered everywhere as required *within the limit of time*, or better results would be obtained. This subject will be alluded to further on, see para. (10).

(9) Iklera Sagar is given as an instance. It contains water sufficient to irrigate 5,800 bighas. Before A.D. 1900 the yearly average irrigated was 1,438 bighas, only about $\frac{1}{4}$ of the full amount. In A.D. 1900, the famine year, although the tank filled, only 4,419 bighas were irrigated. The cultivated area of the 6 villages which it now irrigates is 6,071 bighas; formerly it used to irrigate lands of 10 villages, which consisted of 12,800 bighas of cultivated and the same amount of uncultivated area. It may be said the tank irrigates only 11 per cent. of the whole area.

(10) The Parbati Canal has a bed width of 15 feet side slopes 1 to 1, with a slope of 1·5 feet per mile, and is designed to flow 4 feet maxm. depth. This will give a discharge of 143 cusecs—and allowing the duty (Jackson's Canal and Culvert Tables—Table XI Canal in earth, Class IV below the average) of water to be say 150 acres per cusec. It cannot irrigate more than about 21,879 acres if it always ran full, which it does not.

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* *Bighas. Acres.*

$\frac{10137}{150}$ bighas $= 107{\cdot}6 = \frac{107{\cdot}6}{9} \times 4 = 47{\cdot}8$ acres.

The whole of the water of the Parbati Canal is not utilised; about $\frac{1}{4}$th is discharged to waste up to December every year; and owing to the length of distributaries much is lost.

Some arrangement, the Consulting Engineer thinks, should be made to prevent the waste by storing the water in places *en route*.

(11) He gives a list of 32 works (mostly small) which were made by the late Mr. Miles within the last 23 years, which have not, he states, proved a success. Although they contain sufficient water to irrigate *rabi* crops till the end of the season, yet the water is not used. It is believed that these were not intended for irrigation so much as for storing water for the village use.

The Consulting Engineer thinks it would be advisable to find out the reason, and to enquire from the zamindars what they have to say. A summary of the replies from the Nazims is given in Appendix No. XVII.

(12) A List of 8 works carried out by Mr. Tickell is given, which he states have proved a failure.

(13) Hundreds of estimates for Irrigation Projects, he states, were made in the time of the late Mr. Miles, amongst them the projects of Canals from Parwan and Kali Sindh Rivers, through the heart of Haraoti; and for making tanks in different localities. All had to be given up, as it was feared they would not be remunerative.

(14) Does not think the return of Rs. 2 per bigha, or 11·5 per cent. anticipated by Mr. Tickell will be realised.

The returns on the works constructed during the past 23 years only give 3 per cent. and the average on the Ayani Tank, which Mr. Tickell gives as $6\frac{1}{4}$ per cent. if calculated on the last 10 years, only gives an average of 1·5 per cent.

(15) It is not the practice here to irrigate *kharif* crops as Mr. Tickell supposes. Only a few fields of rice and tobacco are irrigated.

(16) He does not advocate large Storage Reservoirs on the big rivers, mainly on account of the danger and expense involved.

(17) The catchment areas of the existing tanks, he thinks, is not so small as Mr. Tickell imagines, as more than half the tanks fill with a moderate rainfall.

(18) It is not safe to anticipate that wherever water is stored, it will be utilised.

Suggests water should only be stored according to requirements, in the vicinity of those places only which require irrigation, and which are inhabited by cultivating classes, and even then a profit of more than 3 per cent. should not be expected.

In the opinion of the Consulting Engineer, all this is sound advice.

24. Works which he considers will be profitable to the State and the people are as follows (his para. 18) :—

(*a*) Construction of tanks where the soil is suitable, and where there are people to cultivate. The size of the tank to depend upon the area to be irrigated.

(*b*) Storage of water by bunding nullahs where water in the wells is deficient, or at a great depth, and does not permit poppy cultivation ; only those nullahs in which water flows till November or December to retain water till the end of March, and enable poppy cultivation to be carried on by means of "charas" at the river banks. These works have been tried and have proved very successful.

(c) Sinking of wells for poppy cultivation at Rs. 1,000 each. Wells made in A.D. 1900 will, it is said, give a large profit. This requires no extra professional skill.

(*d*) Construction of *kutcha* bunds to divert streams. Some works of this kind were lately constructed, and lands which formerly formed the bed of the stream were brought under cultivation and gave a profit of more than 50 per cent.

(19) He does not altogether agree with Mr. Tickell regarding the works suggested in Appendix B, of the printed Report. The leakage is due to the nature of the substructure at the site.

25. Regarding works in Appendix D, he does not approve of Mr. Tickell's proposal to revise and raise the estimates from Rs. 31,000 to Rs. 1,95,000 until the water of these tanks is fully utilised and the zamindars want more water.

He suggests all works under construction should be finished according to the original estimates ; they can be improved and enlarged afterwards if found profitable.

Regarding works for future consideration (his para. 21) Appendix E of the printed Report—sixty-seven works at a cost of Rs. 44,59,000—he is of opinion that only 16 at a cost of Rs. 13,42,000 are such as will

protect in a year of famine: out of these 16, four at a cost of Rs. 51,000 will, he thinks, pay 3 or 4 per cent., *viz.*:—

Ana Sagar	...	...	...	Rs. 2,000
Shahabad Saran	...	...	...	„ 12,000
Simlode Tank	...	...	...	„ 20,000
Atralia Tank	...	...	...	„ 17,000
			Total	Rs. 51,000

He gives a list of 11 other works which at a cost of Rs. 4,99,000 would, in his opinion, be of a protective nature and profitable in times of normal rainfall.

These together with the 16 works previously alluded to would make a total of 27 works at a cost of Rs. 18,41,000. (See Appendix No. XVIII).

He concludes his report by suggesting that the cultivators should be consulted before works are carried out, to avoid the disappointment alluded to in para. 11—a sound bit of advice.

26. Causes which it is believed retard irrigation in the Kotah State:—

(1) The large area of black soil which is already under cultivation of *Katha* wheat, a species of wheat which is extensively grown on black soil and does not require watering.

The ground, where there is black soil, is broken up after the first fall of rain and the seed is sown. If timely rain falls, the *Katha* description of wheat requires no further labour. Excessive rain does it harm. Some officials have gone so far as to express an opinion that any attempt to supply water to *Katha* wheat would do more harm than good.

(2) The cultivators are stated to be wanting in energy and regardless of the advantages of irrigation, and consider the extra profit it might bring is not worth the extra labour. Perhaps the ease with which the wheat crop is realised, as noted above, may largely account for this.

(3) The want of people to take the water if stored. The Kotah State lost about 24 per cent. or more of its population, owing to and after the recent famine.

It is stated that the area of culturable *Khalsa* land now uncultivated is about 849,947 acres.

The Durbar are offering land on liberal terms to induce foreigners to settle. This is a wise measure.

(4) In some places, it is thought the people are averse to taking water, even if within reach, because they are afraid if they do take water, the land irrigated, if not already assessed *piwat* or irrigated, will be charged as such; that the supply of water may not continue regularly, or may not be enough to warrant the increased charge, and that they may be losers in consequence.

How far this belief is justified it is difficult to say, but if the belief does exist, it is enough to retard the progress of Irrigation.

It needs someone to take an interest in the subject and to explain matters to the villagers and to help them, as suggested in para. (8.) The Nazims are stated to have power on sufficient cause to make remission or to refer to the Durbar; whether they have leisure from other duties to take a greater interest in irrigation matters is doubtful; it needs a man's heart to be in a subject to succeed.

(5) The water is generally only about 25 to 35 feet below the surface. This no doubt makes the need of irrigation less than it would otherwise be.

(6) People are said to be afraid of blight attacking the wheat if it is freely watered.

In cases this may have occurred owing to excess of rain, or to cloudy weather or other causes. But crops judiciously watered are undoubtedly benefited, and experience would no doubt dispel such fears.

(7) In some places, the conservation of Forests, in affording greater protection to wild animals, is stated to discourage cultivation, and cause difficulty to guard the crops.

An instance of this is given, where efforts to found a settlement near the Parbati Canal lately had to be abandoned for this reason.

(8) The absence of proper control and supervision, and want of interest in the subject.

As an instance, the Khandela Tank near Asnaur may be mentioned. Here is an old tank on which about Rs. 30,000 were spent 15 years ago, and some irrigation was done for 2 or 3 years.

The ducts fell into disrepair, and for 10 or 12 years nothing has been done and no irrigation has taken place, because no one appears to have been responsible.

It is only right to say that since it has come under Kotah, the present State Engineer, Mr. Devon, has taken the matter up and himself took me to the place. (See Appendix III).

If such an official is not already appointed, what is wanted is a Zilladar of Abpashi, who will be held responsible for the progress of irrigation.

He should be a man of active habits and of a conciliatory disposition—a native of the State.

He should visit every work, and should keep a journal in half-margin of his occupation and duties. He should enquire into all complaints or requests regarding irrigation matters, and represent them to the proper quarter. He might be placed under the orders of the Engineer Officer and on his retur from every tour, he should show him his journal, for information and orders. He should see that all obstructions to the progress of irrigation, whether real or imagined, are promptly removed; that water is properly used; and at the end of the irrigation season he should furnish every cultivator who has taken water with a printed chit or *khat-khatoni* stating the amount to be recovered, and a copy to the Revenue officials to recover in the usual way.

He must be a man who will work without friction, one to whom the villagers can look up to as a friend, and in whom the Durbar has confidence.

(9) The necessity that water shall regularly, fully and promptly meet the demand *within the limit of time for watering.* A canal or tank for instance which supplies water intermittently, in some years much water, in others less, or none, makes cultivators distrustful and disheartened. There is doubt whether if a crop is sown, it will be fully matured; or if water is offered for the first watering when the time is past, the ground will then perhaps be hard and dry, and even if water is offered free, it is of no use. Results such as these will naturally retard irrigation.

(10) Irrigation Projects which are intended only to supply water to land already irrigated from wells, or to land which does not require water, or where there are no people to take it, will naturally not pay.

(11) It appears the land is assessed on certain terms for each class or description of soil.

If water is supplied from any tank or canal, only the water rate, eight annas, in some cases a little more, is charged; and this is all that is shown as the profit due to the work.

It does not show the profit derived by the State or by the cultivator, as the case may be, and this after all is the chief object of irrigation.

A small percentage shown as profit, might discourage irrigation generally, but there is no expenditure which can benefit a State so much as money spent on irrigation. It is money in circulation, spent among the people of the State, and enriches them. It is like seed sown in a field, it is sure to be returned with interest in one way or another.

27. The Consulting Engineer has visited all the places that the State Engineer, Mr. Devon, wished him to see. His remarks on each will be found in the Appendix, *viz.* :—

The Kali Sindh River	...	Appendix	II
„ Khandela Tank	...	„	III
„ Bara Ujar Tank Project	...	„	IV
„ Ujar River Site for Storage near Mau	...	„	V
„ Chapi „ „	Ghar Taraj ...	„	VI
„ Parwan „ „	Manpur ...	„	VII
„ „ „ „	Akond ...	„	VIII
„ „ „	Head Works near Shergarh ...	„	IX
„ Parbati Canal	... ...	„	X
„ „	Site for Storage near the Head Works	„	XI
„ „ „ „	Baran ...	„	XII

28. It has been impossible in the short time available to see more; the most he can do is to give his opinion on such works or places as he has seen, and to state the policy he considers best to promote irrigation in this State; this he has endeavoured to do in these Notes.

29. The present State Engineer, Mr. Devon, evidently takes an interest in the subject of irrigation, and if he only gets the opportunity will no doubt make irrigation a success. He rightly proposes first to take in hand works which are not complete.

SUMMARY.

1. The country is admirably adapted for large storage tanks. It is possible to make them, and only such works as have an unfailing supply of water can be considered really Protective, but the magnitude of such works makes it advisable not to begin them until Plans and Estimates have been approved and the necessity is clear.

2. In the meantime advantage might be taken to construct smaller works on the poorer soil, or in such places where it is certain the water will be used; and where there is the certainty of their being filled every year, either from their own catchment, or from rivers or nullahs near.

3. The advisability of utilising, where possible, the running water in rivers or streams, either to fill existing or proposed tanks, or by making submerged weirs to form pools, in such places as will enable wells at the side or below, to be used for cultivation of land on the banks, and where stone is plentiful and no expensive foundations will be required.

4. The greater benefit to the country generally by carrying out such works, instead of large and grand storage schemes which require years to prepare, to make and to develop, and where the expenditure will be all in one place.

5. The advisability of reparing Plans and Estimates for works that will irrigate lands situated on other than black soil, and only in such places as are approved by the Revenue Officials and the villagers concerned, who should always be consulted.

6. The advisability of completing work already constructed but incomplete such as the Parbati Canal, which requires storage tanks to do its full duty, and to make it a success. This is one of the first duties the present State Engineer proposes to undertake, and he is quite right.

7. If it is not already prepared, a list should be prepared, showing every tank, the quantity of water it will contain at every foot in depth, and the corresponding area which could be irrigated, if the water is properly used.

This is a good check upon the use made of the water.

8. The Revenue Officials always to take some guarantee from the villagers before a work is constructed, that will ensure a fair return for the outlay.

9. The need of better supervision by some qualified person to ensure the progress of irrigation.

10. The necessity of canals to be large enough to ensure a regular, full and prompt supply of water, sufficient to irrigate all the land requiring water *within the time limited for the first watering*, say 30 days.

11. A liberal policy as regards the construction of wells, as the water is generally near the surface and the supply good at all times; especially to have wells below existing or proposed village tanks. (See opinion of the Revenue Superintendent, para. 24 (c).) Wells made in A.D. 1900, it is said, give large profit.

12. The need of a fixed policy, if progress in irrigation is desired (1) in the preparation of projects; (2) in carrying out of projects. (See para. 19). A liberal grant to be set apart annually, and work once sanctioned to be vigorously carried out to completion.

13. An Annual Report to be submitted showing the progress of irrigation in the State. It should be printed to facilitate reference and record. It should contain a brief account of any Surveys made, or Projects prepared, during the past year.

The following facts should also be noted :—

(1) The rainfall.

(2) The amount spent on irrigation during the past year, including all charges.

(3) The total area irrigated.

(4) The total amount realised by the Revenue Department for water rate, or whatever may be due to Irrigation.

If these are noted in graphic diagram form, one page will contain all the above information, and will admit of being added to every year, and it will form an interesting record.

Where a State, or an Officer, has made efforts to promote Irrigation, the opportunity to show this record will be gladly taken and appreciated.

14. Irrigation has not hitherto been as successful as it ought to have been, because some of the points noted above have not been fully attended to. There is not the slightest doubt that irrigation will be a success, if it is properly carried out as suggested, and if it is taken up with heart and soul.

The progress and the results of irrigation will depend upon the real interest taken in the subject by the Durbar and by all concerned.

S. S. JACOB, Col.,
Consulting Engineer for Irrigation.

APPENDICES.

APPENDICES.

Map showing the chief Drainage Areas in the State.

APPENDIX I.

Extract from letter No. 134, dated the 16th September 1901, from the Diwan, Kotah State, to the Political Agent, Kotah.

2. * * * * *

"The Durbar cordially desire to co-operate with the Government of India in their most admirable and Statesman-like policy. They can quite appreciate the advantages pointed out of having such a programme of Famine Protective Works ready to be taken up in the event of future famines. But in this connection, I am to forward a Note* written in Urdu by the Revenue Superintendent of the State, showing in detail the general unsuitability of the soil of the country to irrigation, and to ask that before this programme is finally accepted and passed, a more thorough local inquiry may be made by an expert respecting the nature of the soil which it is proposed to irrigate from the works suggested.

3. Past experience shows—

(1) That the land of the country, generally black cotton soil does not want irrigation except for poppy;

(2) That the poppy crop, though valuable, is very expensive and exacts more labour and care than other crops, hence its expansion is limited by the general ability and agricultural resources of the cultivator; and

(3) That area under poppy does not exceed 5 per cent. of the total cultivated area. A land-holder of 80 or 100 bighas has seldom more than 5 bighas under poppy, the rest of his land being devoted to *juar*, *tilli* and cotton in the *Kharif* and to wheat, gram and linseed in the *Rabi*.

(4) To grow wheat, the staple produce of Kotah, land here, unlike land in other parts of India, does not require irrigation. In fact it suffers from it, also from any excess in the year's rainfall. So that whatever value the proposed large Irrigation Works might have in times of famine, in ordinary years they would yield but little profit.

(5) Such being the result of past experience the Durbar think that only such of the works herewith suggested, or that may hereafter be proposed, should be marked down for construction, as may be not only an insurance against famine in years of drought, but which will also yield a reasonable income in ordinary years.

(6) We are further considering what other works, besides Irrigation Works, can be suggested as Famine Protective Works to be included in the programme, and may be able to make a further communication later on."

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* A summary of this Note is given in para. 23.

APPENDIX II.

Kali Sindh Canal.

21st January 1904.

In the morning we inspected the Kali Sindh River from the junction with the River Au at Gagron to the second gorge below. Nothing seems possible at the first gorge without flooding back on to Jhalrapatan land. At the second gorge, to which we walked along the edge of the river, the site is an exceedingly good one for a dam; the gorge is about 300 ft wide, and the water would have to escape over the dam. The gorge is in hard rock and might be safely trusted, but owing to the contracted nature of the storage, it is not a very good place to store water.

Some plans in pencil were produced at site, but these are not complete.

At 4 P.M. we rode to Khanpura, about 6 miles north, to see the site where Mr. Tickell, late State Engineer, proposed to place the head works of canals to take off here from the Kali Sindh River and to irrigate the land on both banks. Some pencil plans of the proposed bunds and tracings of the proposed canal line on the left bank were produced, but there are no bench marks to fix the places.

The site for a weir is good, *viz.*, just below Khanpur and above where the river widens out; there is rock everywhere across in the bed and on both banks.

22nd January, Rajpura.—Walked to the River Kali Sindh which passes about ⅓ mile east of the village, and examined the river from the place where the banks are high and the bed narrow, to a point about ½ mile up stream, where the river bed widens out and the water falls a few feet.

It was above this latter place that Mr. Tickell proposed to make a storage bund. The whole project is thus described in the printed Report on Irrigation in the Kotah State.

The Kali Sindh Canal in the Kanwas Nizamat, catchment area 3,500 square miles. It is proposed to bund the Kali Sindh River at three places: near Gagron, Rajpura and Khanpur. These three bunds will impound about 500 m. c.ft.

From the lower of the three bunds, *i.e.*, near Khanpur, two canals will take off—one on the left bank about 15 miles long to irrigate 15 villages, and one about 8 miles long on the right bank to irrigate 7 villages: total 22 villages.

The discharge of the Kali Sindh River was measured by Mr. Tickell on 1st December 1900, and he states it was then 213 c.ft. per second.

The canals, he says, may discharge 100 c.ft. each per second. The *Kharif* canal on the right bank being closed in November, the natural flow in the river will be sufficient for the left bank canal in December.

In January the natural flow, he says, may be safely taken at 50 c. ft. per second, and in February it may be assumed to be *nil.*

The reservoirs will then hold enough water for the *Rabi* canal on the left bank up to the middle of March.

The right bank canal will, he states, be capable of irrigating 3,000 acres, the left bank canal about 6,000 acres, and the project should pay about 9 per cent.

The capacity of the tanks is stated as 500 m. c. ft.—the percentage of 1·6′ of a 30″ rainfall would be required to fill the tanks. Three masonry bunds to be constructed 3,000 ft., 2,000 ft. and 200 ft. long. The estimated cost as Rs. 3,00,000. The estimated irrigated area is stated as 13,500 bighas and revenue at Rs. 27,000, which would give 6 per cent. profit.

The uppermost of these three bunds is said to be proposed at Gagron; the second about ½ mile below the Fort of Gagron; and the 3rd near Khanpura. There seems some doubt as to the site of No. 1. Mr. Tickell in the above remarks mentions it as being near Gagron, whereas in the latest map he shows it to be at or near Barosa, about 8 miles above Gagron.

This site I have not seen, but it has the drawback of having the Jhalawar State on one side; the second has the objection of limited storage; the 3rd also does not appear to be the best site for a storage tank. The plans and estimates do not appear to have been prepared fully, and it is not clear on what data these figures are given, or whether the works could all be done for the amount stated, or whether the results would be as anticipated, or whether the Revenue Officials have been consulted.

If a storage tank is to be made on the river, the best site (as far as I have seen) appears to me to be east of the village Rajpura, because the river narrows here, and the basin for storage above it is large, and only waste land would be submerged. None of the other sites apparently have such advantages.

To construct one large reservoir has advantages over three reservoirs miles apart, both in construction, in maintenance and in control, and there is less chance of any loss of water, when the water stored is near the head works of the canals. There appears to be no fear of any silting up, as the catchment is mostly hard rocky ground.

It is true a bund here would have to be higher, unless any depression is to be found at the side to pass off the surplus water over the high rocky ground on each bank; but until cross sections and estimates have been made, it is difficult to speak with confidence. The basin is all barren waste land. There is any amount of good stone for a masonry bund, and there would be no difficulty about the foundations, as rock is visible right across.

There might be leakage through the stratified rock at the sides or below, but this would all be caught by the head works of the canal at Khanpura, about 4 miles lower down.

I have not been over the line of the canal, but assume it is correctly aligned and on the best land for irrigation.

If a storage tank is not made on the river, it would be necessary to select say 4 or 5 or more good sites on the country commanded by the canal, one below the other, and if they did not fill from their own drainage area, to fill them by means of the canals. This could be done at any time towards the end of the rains, when the canal water was not required for irrigation, and would, if not stored, be running to waste.

In any case the weir to supply the canal would be necessary, whether it is to be used merely as an irrigation canal or as a supply canal, or both.

The question which remains to be decided is, whether the storage upon which the success of the canal will mainly depend is to be on the river itself, above the weir at the canal head, or whether the water is to be stored by large earthen bunds, at convenient places commanded by the canal.

Unless the canal is able to supply water everywhere *when it is required*, it will not fulfil its purpose.

Tanks at convenient places, each sufficient to meet the demands of 3 or 4 villages, will enable water to be given practically simultaneously everywhere, and would, no doubt, meet all the requirements of the villages.

The tanks need not all be made at once, but 2 or 3 might be made first, and if they answered, any number might be made as funds were available.

If judiciously located they would do great good. Earthen bunds also can be made, as a rule, any size, and can often be enlarged afterwards. If sluice boards in grooved pillars are put on the crest of the waste weirs, and the planks are put in when the rains are nearly over, the capacity of each tank can be considerably increased.

What seems desirable is to have alternative schemes drawn out (*a*) with a large storage tank on the rivers; (*b*) with several large earthen tanks at convenient places, on the surface of the country.

The head works, *viz.*, the weir near Khanpura and the canal being common to both schemes, the estimates for each to be made and compared, and the opinion of the Revenue Officials to be taken from a revenue point of view—whether irrigation in the area commanded is necessary or otherwise. When the data for each is known, it will be easier to decide.

Either scheme would be an insurance against famine, and would irrigate the whole of the tract of country commanded.

An ideal scheme would be to have a large storage reservoir in the river, with a weir and canal below it, and to have small tanks near each important circle of villages which could be fed, not only in the rains, but

as often as required, from the storage reservoir by means of the canal, which could then fulfil the double purpose of a feeder to these small tanks, as well as an irrigation canal, so that irrigation might go on everywhere at the same time.

This, of course, would cost a large sum, but I believe there would be no question as to its paying well.

As an insurance against famine it would be the best arrangement possible.

APPENDIX III.

Khandela Tank.

24th January 1904.

From Asnawar rode to Khandela at 3¼ P.M., 10 miles altogether, to see an old Irrigation Work, a tank prettily situated in the valley between the two ranges of hills, about 5 miles north-east of Asnawar.

The late Mr. Miles made a sluice to this tank and ducts to lead the water away for irrigation. The water was let down the nullah bed for about half a mile, and then by a small masonry bund was diverted by two ducts right and left. The ducts are taken on high and rocky ground, and the water cannot be used until it has been taken about a mile or so. These ducts need repair in places, and the nullah bed near the sluice requires to be cleared of undergrowth.

There is an iron sluice in a masonry well in the bund, and a small masonry culvert or tunnel through the bund.

The steps leading to the sluice valve inside the well are broken in places. The valve is worked from below; it has no raising rod.

There is now (24th January) about 12 ft. of water against the bund. The surface of the water is now about 10 ft. below the top of the bund, and since the last rains, appears to have fallen about 1½ ft. The tank is said to have partially dried up in Sambat 1956 (A.D. 1899), and then although there was no water near the sluice, there was some still left on the other side of the lake, showing that to be the deeper side, and that the present sluice does not drain off all the water.

There is no record of the amount of water available or of the capacity to the tank. The Diwan of Kotah, it is said, visited this place about two years ago. The State Engineer (Mr. Devon) also saw the place and gave orders for an estimate to be prepared for whatever repairs were necessary.

Some cultivation was done in the bed of the tank when the water receded in A.D. 1900, and irrigation from the tank for 2 or 3 years, it is said, when the scheme was first started, and after that ceased entirely, but nothing like the full use of the water appears to have been made.

There is any amount of good land between the tank and the villages below, in the direction of Asnawar.

From enquiry it appears there is no one authorized to deal with the water, no one held responsible for the proper distribution or to encourage irrigation. This is a weak point.

The following points are suggested :—

(1) Some one should be held responsible for the distribution of the water. Some one to encourage irrigation, who should work in harmony with the Engineering Department and with the Revenue, and be under one or the other; under the Engineer, perhaps, would be the best.

(2) The capacity of the tank should be ascertained, when possible, so as to know what amount of water is available for irrigation, and a gauge be fixed to show the depth of water at any time.

(3) The steps to the sluice valve should be repaired and the undergrowth be cleared, to allow the free passage of the water.

As regards the ducts, it does not seem advisable to go to the expense of repairing the old ducts as originally designed, as they are on sloping rocky ground, where the water cannot be used for some distance, and are liable to require frequent repair.

A better plan appears to be, to construct another small bund on the nullah below the existing lake, at a place below the village of Tandi and just above a small hamlet of Sonpura.

There is a good basin of hard rocky ground on which there is no cultivation. A bund here about 600 ft. long or so, about 25 ft. high, would intercept the drainage of about 3 sq. miles, all the water of which now goes to waste.

There is a natural ridge of hard rock between Tandi and Sonpura about 400 ft. long, which will form a good escape. The cultivated fields of Sonpura will not be injured, as they would be outside and below the proposed bund, and the wells below the bund would be greatly benefited.

The land where irrigation would begin is not far below the bund, so that there would not be any heavy expense for ducts or any waste of water, nor need of annual repairs.

It seems to me that it would be better, not to spend money in repairing the old ducts on the high ground, but to spend it in making the lower bund instead, as it will be far more useful if devoted to such a purpose, and will store water which now goes to waste, and will catch any leakage from the upper lake. When the water in it is all used up in irrigation, the water from the upper (existing) lake can be let out into the proposed lower tank to continue the irrigation, and this will ensure a large tract.

APPENDIX IV.

Bara Ujar Tank.

The late State Engineer (Mr. Tickell), has printed a report on the proposed Bara Ujar Project, from which the following information is obtained :—

The existing works consist of a small storage tank near Bara village, with a low level bund at the village of Tokri 6,200 feet lower down. The latter has outlets on both sides for two canals. The right bank canal has been partially constructed with three aqueducts for about 3 miles.

The water stored by the two bunds is only 23 m. c. ft., and as this was obviously too little for irrigation, the work has been left unfinished for many years.

One would naturally have supposed that this was the very reason why the work should not have been left unfinished.

From conversation with the people it seems they did not freely take the water when it was available, because they had water sufficient in the wells. They were not satisfied that there would be enough water to meet all their requirements, and there was some fear on their part that they would be called upon to pay the difference between barani say Rs. 1-3-0 and "pivat" or irrigation land, which would probably be Rs. 5 or 6, and they accordingly held back.

If there had been any authorised persons to set their minds at rest on this point, and the supply of water had been assured, it is quite possible the results might have been different. As it is now, the Raj have spent over Rs. 30,000 here and realised nothing. This is very unsatisfactory.

Mr. Tickell goes on to say: "The project, if properly completed, is a most promising one," and I quite agree with him.

It is proposed now that "the Bara bund shall be strengthened and raised 30 ft., and an excellent tank will thus be found containing 1,021 m. c. ft."

"The low level bund at Tokri to be raised 3 ft. The outlets to be improved and the canals constructed on both sides of the river. The existing canal is well-aligned and only requires remodelling and extending, but the left bank canal requires to be entirely constructed, nothing yet having been commenced on this side."

"The drainage area is 56 sq. miles, the catchment being rocky with steep slopes."

"The average rainfall for 6 years is 36 inches. It is safe to assume that 22 per cent. will be collected; 22 per cent. of 36 inches on a catchment of 56 sq. miles will just fill the tank to its full capacity of 1,025 m.c. ft.

The amount available for irrigation will be in

the Bara Ujar Tank	1,015	m. c. ft.
Low Level Tank	10	„
Total	1,025	„

"The right canal commands 7 villages the left canal 18 villages."

"In a bad year (such as 1899) with a rainfall of 21 inches, 20 per cent. run-off may be calculated upon, and 544 m. c. ft. will be stored."

"It is possible, however, and probable that in ordinary years the tank will fill 1¼ or 1½ times. Assuming a duty of 100,000 c.ft. of water per acre, the total irrigation would be 22,060 bighas."

The duty proposed is 10 acres per m. c. ft., this is 155 acres per c.ft. for both seasons.

If it is assumed that "the tank will irrigate 6·4 acres per m. c. ft., which is the average of 5 tanks in the Kotah and Jhalawar States, the profits will be 14,700 bighas at Re. 1-3-0 per bigha = Rs. 17,527

Less loss of revenue of 6 submerged villages ,, 232

Net profit ... ... ,, 17,295

which represents 11 per cent. on the cost of the project.

The results recorded of the four principal Irrigation Works in the Kotah State since 1895 give an average net profit of Re. 1-2-9 per bigha.

"As a Famine Relief Work the project would not have much value, as only about Rs. 12,000 could be spent on unskilled labour such as earth-work."

As a Protective Work against famine Mr. Tickell says: "I know of no work in the State that would have greater effect"

The canals command 29 Khalsa and one Jagir villages.

When it is considered that only Rs. 1,26,486 are required for this work, the existing work valued at Rs. 30,000 being practically useless in its present state, the profits on an estimated revenue of Rs. 10,721 only would be 8 per cent. and might be more.

The cost per m. c. ft. of the water stored is Rs. 152. The maximum height to which the tank could ever rise with 15 inches of rain in 24 hours is calculated to be 4 ft.

The villagers state that in the famine year their wells failed, there was only water sufficient for drinking, and that about two years ago they petitioned to have something done.

The present State Engineer, Mr. Devon, is, however, quite alive to the importance of irrigation, and is keen in making irrigation a success, and rightly considers important works such as this, which have not been properly completed, should be completed first and without delay.

REMARKS ON THE PLANS.—*Design for the Masonry Bund.*

1. The proposed bund is shown as built on the down stream side of the existing bund. If there is good rock on the upper side, a good deal of masonry might be saved by putting it there instead of in the hole below.

2. Although the bund has been designed to just fill with ordinary rainfall, Mr. Tickell states it will probably fill 1¼ or 1½ times in ordinary years.

If so, the surplus water will pass over the bund. In this case there will be a fall in the centre of about 45 feet or more. It would be better to raise the centre portion over the river 4 ft., so as to let any surplus water only fall 10 or 15 ft. at the most, or pass over the natural rock surface at each end, making guide walls at starting, to prevent any overflow passing near to the masonry bund on its way to rejoin the river.

3. From the cross sections there appears to be a separate course of masonry at the top (perhaps of stone on edge) showing a horizontal joint across, between it and the masonry below. I would suggest the whole bund, whatever its height, being made of one mass of rubble masonry, without any horizontal courses.

Regarding the Sluice outlet.—I am not sure if this is correctly drawn, but as far as I understand it—

(1) Looking at the ground plan—the outer valve appears placed wrongly, the water would press the face away from its seating instead of against it.

(2) If it got out of order there appears to be no means of shutting off the water from it.

(3) The solid masonry between the two valves is not intelligible.

(4) The necessity for an high level sluice is not apparent; nor for the grooves outside the bund, at the outer toe, in line with the lower iron sluice outlet.

(5) Guides are not shown to keep the sluice rods vertical, and are necessary.

(6) I think the ordinary iron reservoir sluice valve, or two sluice valves, both with gun-metal faces, fitted on the outer side of the sluice wall, a better arrangement, with two similar sluices on the outer side of the next wall. The latter would be the ordinary working sluices, the other the reserve sluices, to be closed in case of need. Everything to be in duplicate.

Regarding the Canals.—Considering that the demand for water is more or less simultaneous, and the necessity of supplying this all within about 30 days for the first watering, the proposed small allowance to each village, I think, will not be sufficient.

The more freely the water can be supplied the better, so as to get as large an area irrigated every day as possible. I should feel disposed to make the canals larger if possible, or the openings to each village also.

It is of no use offering water when the time is past.—For example in this particular case :—

It is stated that the area to be irrigated is 4,600 bighas on the right canal.

		17,450	„	„ left	„
Total	...	22,050 =	about	9,800	acres

allowing one acre = 2¼ bighas.

If one cubic foot of water is allowed over this area as sufficient for one watering (including all loss), it would require 9,800 × 43,500 * c.ft. of water, and as this must be supplied within one month after the rains, it represents a supply of 400 c.ft. per second if delivered in 30 days of 10 working hours.

The right canal ought then to deliver				80	c.ft. per second.
„ left	„	„	„	320	„ „
		Total	...	400	at starting.

The total quantity taken in the Report is only 66 c.ft. per second, which though perhaps sufficient, if the water was delivered over 6 months, it is not sufficient to secure one watering over this large area within the time the water is required. Where there is a canal of some length, then it would be safe to suppose the supply to be continuous for the 24 hours, as the water passed on during the night could be used the next day lower down.

Then for each village, the size of the duct should be proportioned to the areas which the villagers can efficiently manage to use in one day, *e.g.*, the first village wants water for 330 bighas ; if they can manage 50 bighas only a day, it is of no use to give more, and it would take $\frac{330}{50} = 6$ days or so to satisfy this village ; a duct 6 ft. wide 2½ ft. deep with slope of 2 ft. in a mile would be required. When the time was up, the sluice might be closed and the water passed on to other villages, the size of duct in each case being sufficient to irrigate the area which can be attended to by the village in one day; so that within 30 days the whole area should have received one watering ; similarly, a month after, for the second watering and so on.

Similarly with the left canal, theoretically to give 17,450 bighas a full watering once, all within 30 days, it would require 320 c.ft. per second.

The following shows certain discharges with bed widths as noted with a fall of 2 ft. per canal mile of 5,000 ft. :—

Discharge.	*Bed width.*	*Depth of water.*
271·6 cusecs ...	5 ft.	4 ft.
324 ...	30 „	4 „
323 ...	20 „	5 „
291 ...	18 „	5 „

* 1 acre=43,560 c.ft.

This is probably far too liberal an allowance. Such a canal would be costly and might after all not be required, probably only a portion of the land which could take the water will be irrigated, and although this will diminish the anticipated returns, it is, I think, better to begin gradually and to widen or deepen the canals afterwards, as irrigation develops and the need is proved.

While therefore providing ample sluice outlets to meet all future demands, I would suggest the canals being made capable of supplying at first water sufficient, say, to irrigate in 24 hours about one-fourth of the quantity of land noted against each village, increasing this when the demand increases. It takes time to develop irrigation, and it is only when villagers are assured of the supply regularly, and realise the benefits, that they will take water freely.

By every means, in fact to keep down original cost, without sacrificing efficiency; and to meet all demands as they arise.

Regarding Aqueduct.—Instead of making an aqueduct, *if it is possible* and can safely be done, to bund up any nullah, it may cost less to do so; there is the advantage of perhaps taking the water of the nullah on by the canal to where it can be utilised; or by letting it head up, benefiting by percolation any wells below, and if the nullah bed in time fills up, of perhaps reclaiming ground which might otherwise go on cutting back.

In some cases it may be possible to bund up a nullah higher up and divert the water to some other drainage line, and so save the cost of a masonry aqueduct.

Syphons.—I understand these to be masonry arrangements to lower cross drainage and pass it under the canal, leading it away by a cut on the lower side. It may be possible in some cases to bund this water out altogether, or divert it or take it on in the canal.

The level of the canal bed cannot be altered of course, but the bed of the watercourse perhaps might be, and if it is not safe or possible to take the water on in the canal, then by simple level crossings with tilting wooden shutters fixed in cut-stone piers to pass the flood off and to close the opening afterwards for irrigation. There is always a danger of syphons being blocked by brushwood or silt.

Escapes can often be economically made, where the H. W. L. of the canal coincides with the natural ground surface; if there is no bank on the lower side at these places the surplus water will pass gradually over the natural ground.

Inlets may be made to admit water from a higher level by a fall and water cushion, the top of the fall being the level of the upper ground, the water cushion surface being the bed of the canal.

The great thing is to keep down original or capital cost as much as possible without sacrificing efficiency or strength in any case. No expensive masonry works should be carried out until the necessity for them is evident.

APPENDIX V.

Camp Asnawar.

Mau Tank.

Rode to camp at Mau on 26th January 1904. The object was to inspect the proposals for Irrigation at this place.

The late State Engineer, Mr. R. H. Tickell, in the programme of Irrigation Works for future consideration states: "A fine site for a bund and large tank. The river passes through high hills, and there are 22 villages beyond, which can be irrigated. The actual flow in the river is sufficient for the *kharif* irrigation, so a very large quantity of *rabi* irrigation can be done." The length and description of the bund is stated as "two or more masonry bunds. Estimated cost Rs. 2,50,000. The estimated area to be cultivated 15,000 bighas, and the estimated revenue Rs. 30,000, which would give 12 per cent. return. The drainage area is said to be 100 sq. miles and the capacity of the tank 500 m. c.ft."

It is not clear on what data these calculations are based, as none are forthcoming. The only papers produced are a few levels near Mau made four years ago, with the object of making a canal from the river, but these were not completed, and afford very little information.

As regards the Drainage Area.—If the Bara-Ujar project is carried out it will cut off 56 sq. miles, so that there will then be only about 44 sq. miles available. No deduction seems to have been made from the returns for maintenance.

As regards Sites.—The river passes through three ranges of hills, and good sites certainly do exist.

(1) The Sagoreya or Khojkhera gorge.

(2) The Chanpol dey or Khuskherli gorge.

(3) The Chanpol gorge, just below Nai-ka-Chowki and above the village of Mau.

The last I did not see properly, owing to the difficulty of approach; (2) appeared an excellent place for a masonry dam, as there is rock in the bed and on both sides; there are good places here on each side to pass off any floods over solid rock, and there is a fine storage basin and good stone is at the site. The longitudinal slope of the bed appeared less at (2) than at (3), but levels alone can settle such points.

Before a decided opinion can be given as to which site is the best, sections and levels would be required to show what a masonry dam at each place would cost; and how much water could be impounded, and at which site it could be stored most economically, and any surplus be disposed off.

There is no question of the possibility of making a storage tank at one or the other place. It should be remembered that a large work like this takes time to complete, and only when completed can any returns be expected.

As to distribution, the water from (2) would have to be let down the river bed until it reached the canal head, which would be either near the ghât steps below the old Masjid, or at the existing old masonry weir across the river, a few hundred yards below the old Masjid, which would have to be raised some 15 or 20 feet probably, as it is much below the level of the ground on either side. The difficulty will be to get the water out on to the surface, as the general level is some 30 ft. above the top of the existing old weir.

The whole country slopes away towards the north, and there is no doubt the water would gain the required level in time, but until levels have been taken on several lines across the country, it is difficult to speak confidently as to the length, depth, and cost of the canal.

There is low ground in the direction of Bordha, in fact a nullah on the north side of it, which might perhaps be utilised, if this can be done without sacrificing much of the cultivated ground near Bordha. If the water can be passed into the nullah, an earthen bund might be put across it at a suitable point, to raise the water and divert it gradually on to the watershed right and left.

There is plenty of good land beyond, and a good storage tank would ensure any canal being always well supplied. It would be a perfect insurance against famine. It is not work, however, on which famine labour could be well employed.

An alternative scheme, if levels admit, is to select suitable places on the nullahs which join the Ujar River below the village of Mau, and to make storage reservoirs to these places. If they do not fill from their own drainage area, or if full are not sufficient to meet the demand, then to supply them with water by a cut from the Ujar River.

To illustrate the above proposal a reference is invited to the map. The following places suggest themselves for storage reservoirs :—

(1) A point about two miles north-east of Bordha where four nullahs unite.

(2) On the next nullah to the east lower down, below Champakhur, and so on.

Whether it is possible to make storage tanks on any of these nullahs; whether surplus water can be passed; what quantity of water could be stored; whether any cultivated land would be submerged; or whether a supply from the Ujar River could be diverted to them at a reasonable cost; what the cost of storing the water here would be per m. c.ft.; what land would be commanded; are all points which require investigation.

If it is possible, the advantages of such a scheme are, that each storage can be carried out independently. Irrigation from each could be carried out simultaneously, water which now goes to waste would be stored, and the results and returns be quickly seen; they would help any canal system considerably, and would not prevent any large storage reservoir being made at any time on the main River Ujar, and each would be a work on which famine labour could be well employed.

APPENDIX VI.

Ghar Taraj Storage Project.

Left Ametha 8½ A.M. (29th January 1904) drove about 3 miles, then rode to Taraj.

On the way inspected the River Chapi where it passes through a low range between the villages of Kokulwara and Poli, and then where it passes the next range of hills and enters a gorge of bold high rocky hills near the village of Behloa.

This is a good site for a storage tank; there is rock in the bed and at both sides and a good basin. The gorge is about a mile or more in length, and any water stored here would have to be let down the river until it could be diverted by suitable works below.

The gorge here is exceedingly wild, and tigers and bears are said to exist here.

The path by which we went to Taraj was steep and rocky.

In the afternoon the Nazim came with us, and we visited the place where the river debouches from the gorge. There is rock in the bed, but the place is not suitable for a storage bund.

Next morning (30th January) visited Akond and returned 11-30 A.M. distance there and back 17 miles.

The Chapi River joins the River Parwan about 2¼ miles east of Taraj, and following northwards enters a rocky gorge near Akond.

The sandstone rocks are here over 100 ft. high, and in places more or less prependicular for some distance.

There is a magnificent basin for storage, of which a splendid view can be had from the village of Akond, which is high up on the left or west bank.

With reference to storage about Taraj in the printed Report by the late State Engineer, Mr. R. H. Tickell, occurs the following:—

"Ghar Taraj Tank; catchment area 320 sq. mile; capacity of tank 600 m. c. ft.; 3 per cent. of rainfall only required to fill it; one or more masonry bunds; estimated cost Rs. 2,40,000; estimated amount to be irrigated 8,100 bighas; estimated Revenue Rs. 16,200, which would give 7 per cent. on the outlay. A most excellent site for a tank to irrigate 17 villages with canals totalling 32 miles discharging 62 c. ft. per second.

The *kharif* irrigation can be done by the natural flow of the river, and the whole of the reservoir can be reserved for the *rabi* cultivation."

There is not enough data forthcoming to support these statements, or to enable me to give an opinion.

APPENDIX VII.

RIVER PARWAN.—*Site for Storage near Manpur.*

We came to the River Parwan in the direction of Sarthal. There are about 100 laos of water flowing now (30th January). We then went along the left or west bank of the river by the chowki of Mahadeva and Kila Bhimgarh-ki-chowky along the steep rocky cliff overhanging the river, from which we had a good view; then down to the edge of the river and *mid* the village of Patan to Aklera.

This is one of the sites marked by the late State Engineer in the printed Report as suitable for a storage reservoir. He states, "Parwan Manpur Tank—an excellent site for a tank to irrigate 18 villages, the whole of the *kharif* irrigation of which can be done by the natural flow of the river, and 400 m. c.ft. can be used for the *rabi* irrigation with a canal of 50 c.ft. per second. Catchment area 2,300 sq. miles, two masonry bunds of 2,000 ft. and 3,000 ft.; 0·3 of the rainfall required to fill it. Estimated cost Rs. 1,60,000. Estimated irrigated area 6,750 bighas. Estimated revenue Rs. 13,500, which would give a return of 8½ per cent on the outlay."

The site for a storage reservoir at Akond on the River Parwan has not apparently been noticed by the late State Engineer.

As I understand, his proposal was to make large tanks on the Chapi River near Ghar Taroj and on the River Parwan near Manpur, to irrigate the land below by the natural flow of the rivers as far as possible, and to have storage reservoirs at the places indicated, to supply water when the river failed to supply enough.

The sites selected naturally suggest themselves to anyone looking at the topographical map, as excellent sites for storage reservoir dams.

Undoubtedly they are grand sites, but there are no data forthcoming to say if any accurate sections or surveys have been made; what they would cost; what water these bunds would contain; what area would be submerged; whether any of this is cultivated or not; how the water could be taken off for irrigation; what land would be commanded by the canals; what they would cost, or what the returns would really be. These Projects would have to be properly surveyed and drawn up before these points could be answered satisfactorily; and until these points have been ascertained, it is impossible to recommend works of such magnitude. All one can say at present is, that the sites appear magnificent.

APPENDIX VIII.

River Parwan.—*Storage near Akond.*

It appears a grand site. The River Parwan here enters a narrow gorge. There is rock in the bed and on both sides. There is a magnificent basin for storage. There is some cultivation near the villages, but what amount would be submerged it is impossible to say, until the plans have been prepared. The area submerged would, of course, depend upon the height fixed for the bund.

There appear to be two sites where a masonry bund might be put; if a high bund of about 100 ft. or so, there is a good place about 600 ft. north (below) the village of Akond. The difficulty here would be to get a good escape; the summit of the rocky hill on the left bank, beyond the site of the bund would have to be cut away and levelled off, and the quantity to be removed would depend upon the height of the bund.

The other site is about 500 ft. south of (above) the village of Akond, where there is also rock in the bed and on both banks. A broad expanse of rock on the left bank at a lower level would admit of a lower bund, as it would be easier to make an escape here. Some portion of the rock would in any case have to be cut away near the village, but all the material excavated might be used in the construction of the bund, which might be made of such a height in the river portion as to afford a passage over the rock at the west end for the surplus water.

There is a drainage area at this point of about 2,700 sq. miles, and provision would have to be made to pass off safely all the water which could not be stored. If natural escapes cannot be made to do so safely, then large sluices will have to be also made in the dam itself, as provided on the Assouan dam on the Nile (each 25 ft. high by 6½ ft. wide). Automatic sluices might also be provided on the escape, which would increase the waterway for floods, and when the floods went down would impound a few feet in depth extra water above the ordinary H. W. L., which in a large area would mean an immense quantity of water. The expense of under-sluices or of automatic sluices is great and would have to be considered.

Whether a high dam or one of moderate height is preferred, this would depend upon the area which can be irrigated; the water in either case could not be used here, but would have to be allowed to flow down the river until it came out clear of the gorge to a suitable place to take it off by head} works and a canal for irrigation. There is a stream flowing now (30th January) of about 100 laos.

Whether there is sufficient land south of Taraj to be irrigated by canals from the two reservoirs proposed by the late State Engineer and alluded to above, as the Ghar Taraj Tank on the River Chapi, and the Parwan Manpur Tank, seems very doubtful; or whether it would not be better to construct one large storage reservoir at Akond and use the water on the land below Shergarh, is the question; and as far as I have seen, the latter appears to me the better proposal.

There would be enough water to fill reservoirs at all three places if funds admit and it is found to be desirable, but if the question is whether one shall be made at Akond or two elsewhere, then I think the one at Akond would be the better plan.

Whether it will be possible, if a storage reservoir is made, to make a canal above or below Shergarh large enough to carry sufficient water to irrigate all the land within the limited time for a first watering, is another matter, and will be considered when we reach Shergarh.

APPENDIX IX.

PARWAN RIVER.—*Site for Head-Works. near Shergarh.*

We visited Shergarh on the 5th February 1904, and the following note is recorded:—

Mr. Tickell states in his printed Report regarding the site near Shegarh. "Parwan Tank near Shergarh, catchment area 1,300 sq. miles; 500 m.c. ft. capacity of tank; percentage of a 30" rainfall required to fill the tank 0·6; masonry bund, length not stated. Estimated area to be irrigated 15,000 bighas. Estimated revenue Rs. 30,000. Estimated cost Rs. 25,000. Estimated profit on the cost 12 per cent."

There is nothing to show where the proposed bund would be built or on what data these figures are based. We did not see any good place near Shergarh for storage, or for taking off the canal; but as there is rock in many places across the river bed, doubtless a suitable place for Head Works can be found. I would suggest the course of the river being investigated, from the point where it debouches from the gorge in the range of hills in which Akond is situated, down to the village of Katawar, about 4 miles below Shergarh. At this point the river takes an abrupt turn to the east, and there does not appear to be any possibility of making use of the Parwan below this point. The higher up the water can be diverted the better as regards the usefulness of the canal.

The ground below Shergarh appears to slope towards the range of hills to the west, and it will be necessary to have cross sections taken from the river across the country at every $\frac{1}{2}$ mile or so, to determine the best line for a canal.

As far as I have been able to judge, instead of making any storage tank near Shergarh, as proposed by Mr. Tickell, it would appear a better plan to make the storage reservoir near Akond Head Works for the canal, at the best place (to be ascertained) below the range of hills, to divert the water which flows in the rains in the river, by the canal to small storage tanks on suitable sites near villages on the country below, wherever there is good land and people to make use of the water; and also to use the water, which flows for some months after the rains, by means of the canal for irrigation. To make the canal in fact a supply canal as well as an irrigation canal, and when it is found there is not enough water to meet all demands, then to construct a large storage reservoir above it, which would supply the canal with as much water as is ever likely to be required. This, of course, would be an absolute insurance against any water famine, but it is a large project; it would cost a large sum and it would take a long time to carry out and to develop, and unless the water is made good use of might not give a good return on the outlay. Until surveys have been made and plans and estimates have been properly prepared, it is impossible to say more.

APPENDIX X.

Parbati Canal.

Inspected Head Works of the Parbati Canal. This is described in the printed Report as follows :—

"Bund on the Parbati River near Atru Canal is about 35 miles long, excluding branches. The drainage area of the Parbati at Atru is 3,328 sq. miles; in high floods the river discharges 10 to 17 ft. over a weir 1,310 ft. long; such a flood lasts for two or three days.

The average height of the water over the weir in the rains is about 1½ ft., and discharges about 1,500 ft. per second.

The canal discharges 150 c. ft. per second. Water required for 10 months after July 1st is equal to 3,888 m. c.ft. = 1·6 per cent. of the rainfall.

The bund is of masonry 1,310 ft. long, 15 ft. high in the deepest part, back slope ½ to 1.

Average area irrigated for the six years ending July 1899 is 16,137 bighas and net revenue Rs. 9,646. Actual cost Rs. 3,10,547. Number of years since it was completed 15, and net profit up to that date Rs. 62,676

This work was completed by the late Mr. Miles in 1885. It is over 35 miles long, with over 50 miles of branches. It commands 52 villages. The net receipts of revenue for the six years ending July 1889 were Rs. 48,232, so that the work may be said to pay 3 per cent. This is fairly satisfactory, considering that the canal is only useful for *kharif* irrigation and for *rabi* watering previous to ploughing.

In other respects *rabi* irrigation cannot be done, as the Parbati dries up about the end of December. The canal discharges 150 c.ft. per second, and to make the canal an efficient *rabi* irrigation, four months' supply of water should be stored in one or more large tanks at the head. The storage tank or tanks should contain at least 1,500 m.c.ft. These tanks would cost anything from 2½ to 3 lakhs, and if a duty of 60 acres per c.ft. was obtained during the *rabi* season, 20,250 bighas of land would be irrigated say at Rs. 2 per bigha = Rs. 40,500, or 13 per cent. on 3 lakhs."

In connection with this the following is entered in the programme of Irrigation Works for future consideration (Serial No. 19 in Appendix E, of the printed Report) :—

"*Parbati Canal Tank.*—This tank is required to store sufficient water for the *rabi* irrigation of the Parbati canal. The canal discharges 150 c.ft. per second, and so 1,500 m.c.ft. are required for a four months' supply. On the expenditure now proposed 13 per cent. can be expected, but as Rs. 3,10,000 have already been spent on the *kharif* canal and bund, the profit on the total cost would be raised from 3 to 6½ per cent. 52 villages will be irrigated."

The details of the proposed work are entered as " a bund of 18,000 ft. length, of which 6,000 ft. would be masonry and 12,000 ft. of earth; the capacity 1,500 m. c. ft.; 0·63 of the rainfall would be required to fill it. Estimated area to be irrigated 20,250 bighas and revenue Rs. 40,500 ; estimated cost Rs. 6,10,000, already spent Rs. 3,10,000, balance required Rs. 3,00,000. Estimated profit 6½ per cent. on the total cost, 13 per cent. on the proposed additional cost."

There is nothing to show on what data these calculations are based. With reference to this the Superintendent of Revenue, Kotah State (who was at that time Supervisor under Mr. Miles, and in charge of the work when it was made), states (Para. 8 of his Report):—

" If like Jaipur and other places the land of this country was suitable for irrigation, water contained in the Parbati Canal would have been consumed up to 17 miles from the Head Works, and the canal could have irrigated 37,548 bighas belonging to 28 villages, but the area irrigated by it up till now has never exceeded 20,000 bighas.

Originally the Parbati Canal was dug to a length of 17 miles only, but later when it was found that only 3,500 bighas of land had been irrigated, the length of the canal was increased to 45 miles and its distributaries to 150 miles, and generally only land with brown soil and situated near the banks of rivers and brooks was irrigated by the canal water.

The total area which surrounds the Parbati Canal and its branches amounts to 88,009 bighas of cultivated, and 82,805 bighas of uncultivated land, situated in 52 villages, and the canal water is sufficient to irrigate the whole of the above-mentioned area; but the average of the last 6 years shows that only 16,137 bighas, or 17 per cent. of the cultivated area, is irrigated by the canal and its branches," and further on in para. 10 of his report he adds, "as thewhole of the Parbati Canal is not used for irrigation, about half of it is discharged up to December of every year, into streams and nullahs which cross it."

If all the surrounding land had required irrigation, all the water of the canal would have been consumed within a distance of 15 miles from the Head Works, but most of the surrounding land having been proved unsuitable for Irrigation, the canal water in order to irrigate tracts situated here and there had to be distributed into branches extending over 200 miles.

By the extension a large portion of the water is absorbed by the ground or evaporated; hence very little of the water of the Parbati Canal is utilised on irrigation.

Careful experiments made on the Nira Canal near Poona, which has a length of 101 miles with a discharge at the head of 455 c. ft., have shown that the average loss in the canal from evaporation, absorption and percolation, amounts to one cubic foot per second per mile, or 101 cusecs altogether, which is 22 per cent. of the maximum discharge entering at the head.

Observations made on some of the Punjab Canal distributaries showed a percentage of loss varying from 20 to 30 per cent. of their discharges at the head. This is enough to show how any great length of channel must affect the duty of water for irrigation.

When we visited the Head Works to-day (8th February) the level of the water was about 6 inches below the top of the weir. Two of the canal sluices were open, and the water was going down the canal $2\frac{3}{4}$ ft. deep. At the east end of the weir, the upper course of stone on edge had been carried away for a length of 140 ft., and had been repaired temporarily by a thin masonry wall, to keep the water up to its proper level. This damage is said to occur sometimes in the open part of the water, by the impact of large trees brought down in floods. The State Engineer is having this repaired. The Weir is a fine piece of work, and reflects credit on the late Mr. Miles and on Babu Govind Pershad, who was Supervisor in charge, and on all connected with it.

Nevertheless the limited irrigation which is done from the canal, and the length it has been found necessary to extend the distributaries, and the expenses which have been incurred, and the small returns realised on the expenditure, have been the subject of comment, and have, I understand, somewhat shaken confidence in projects of this kind, and in irrigation generally in the Kotah State.

I think there are reasons for this, which if remedied here, and avoided in future, will give satisfactory results. Mr. Devon, the present State Engineer, is determined to do his best to ensure this.

It appears desirable that—

(1) Water which goes to waste now should be stored, either at the head or in suitable places near the line of canal and as near as possible to the land where it is required.

(2) The canal or distributaries should be so designed as to ensure enough water being available for the irrigation of all the land which will take it—*within the time limit, for the first watering.* It is no use to offer water when it is too late to use it.

(3) The distribution of water should be prompt, plentiful and assured. If it is not so, cultivators naturally lose confidence. The Head Works are admirable, but the canal is not large enough; nor is the surplus water stored; for some months all now goes to waste.

The Superintendent of Revenue states that the two main defects at present are:—

(1) There is not enough water in December to meet all the demands for irrigation.

(2) In Mangrol district the canal is too small to carry the quantity of water required.

It appears the bed there is only 5 ft. wide, which is far too small. The side slopes are 1 to 1 and the fall is 2 ft. per mile. A canal of these dimensions if running 2½ ft. deep will only discharge 25 c.ft. per second, and if 45 acres is allowed as a fair duty per c.ft. per second, it could only irrigate 1,200 acres = 2,700 bighas in 30 days. It is said that the area actually irrigated from this branch is 12,000 bighas. If so, 1 c.ft. gives duty of about 480 bighas or 212 acres. It is more likely that the canal does not run 2½ ft. deep day and night for 30 days, and that the large area said to be irrigated does not receive anything like the full supply desired; if so, this would naturally discourage irrigation.

APPENDIX XI.

PARBATI CANAL.—*Storage near the Head Works.*

With reference to the points alluded to above, *viz.*, deficiency of water, the State Engineer, Mr. Devon, proposes to fix wooden planks or shutters after the rains along the top of the bund to hold up 3 or 4 feet of water, and when the irrigation season is over to remove them.

This would create a reserve probably of about 5 m.c.ft. and would be a great help.

He also proposes to make one or more storage tanks (1) between Gordhanpura and Meshpura on the left, or upper side, on the west bank for the storage of water for the first 17 miles; and near Baran (*) or Niana for the irrigation of the land below that point, or wherever the ground admits; and to fill these up, the former from the river, the latter from the canal, in the rains, and to use the water afterwards for irrigation. This will be a great help to the canal.

The water can be had but goes to waste; the land and cultivators are ready to receive the water, and it only remains to give it *at the right time.*

I fully approve of these arrangements, and recommend that they should be carried out as soon as possible.

(2) Mr. Tickell, the late State Engineer, had a project surveyed for a storage tank near Gordhanpura alluded to above, to hold 530 m.c.ft. and to cost 2½ lakhs of rupees: the greatest depth of water to be 20 ft. I think it would be possible to make considerable reductions in this estimate by omitting masonry work in escapes, and dry stone pitching, and making the height above H. W. L 6 feet instead of 10 ft. If the work can be done for about a lakh of rupees it would mean that about 5,000 c.ft. of water could be stored for a rupee. There would be no outlay for the ducts, as the canal is ready and would catch any leakage that might occur. It seems a very necessary and promising work, and I strongly recommend plans and estimates being prepared at once, and if the Durbar approve, that it be carried out as soon as possible.

I do not think a work of such magnitude as suggested by Mr. Tickell at the Head Works, *viz.*, a bund 18,000 ft. long is advisable, nor that it would be safe to raise the present masonry weir with masonry, but it can be safely and economically done, as suggested by Mr. Devon.

Another suggestion is to take advantage of any depressions on the upper side of the canal where it crosses drainage lines, or low ground, and by making earthen bunds from the canal banks to the higher ground, to make places where water in the rains could be stored, and which could in some cases be filled by cuts from the river at the head, or from the canal if necessary, and the water could, after the rains, be let out into the canal and give it great help in the irrigation season. A portion of the bund in these cases is already made by the canal bank. The escapes from such storage places might be either into the canal itself, or at one end,

(*) See Appendix XII.

so that the overflow from one basin may be made to pass into the next basin lower down. There is a large area above the left bank of the canal all the drainage of which is entirely lost.

Another suggestion is to take advantage of any ground on the lower side of the canal, where a nullah having crossed the canal runs parallel to it for some distance, below syphon No. 1 for instance; there is high ground on the further or east side of the nullah, and if an earthen bund was thrown across the depression, from the high ground to the canal bank, it would apparently be possible to make a small storage tank which could be not only filled but kept full from the canal, and the water could be used as required for irrigation. This appears to be an admirable place to plant a new hamlet.

Very little use appears to be made of the canal water for the first 17 miles, and there is apparently any amount of good waste land on each side of it. It would seem advisable to encourage immigrants, who are stated to be desirous of taking up good land and are being located in other parts of the State, to settle here, as water is assured.

I cannot help thinking the main reason more irrigation is not done is because there is not enough water.

One drawback brought to notice is the destruction which would be caused to any crops grown near the canal in these parts, owing to the wild animals which are said to abound in the jungle near. How far these fears are justified it is difficult to say, but it is stated that recently an attempt was made to settle here and it had to be abandoned for this reason.

I do not approve of masonry syphons under the canal, one of which has lately been constructed. They are expensive, and there is the chance of their being obstructed by brushwood or silt.

APPENDIX XII.

PARBATI CANAL.—*Storage near Baran.*

As regards the Storage Tank near Baran or Niana no project is ready, but I would suggest investigation should be made to select a good site, where little or no valuable land will be submerged and where water can be economically stored. The canal water should, if possible, be passed into the nullah above Baran which leads to it—and a good large canal be made from the tank onward, large enough to give water sufficient for the first watering in 30 days to all the lands below. There is not the slightest doubt it would pay well.

The present canal to the eastward of Niana might then be left for the present as it is; if it is found to be insufficient to carry the water required it could be enlarged at any time. At present full advantage cannot be taken of the water when it is available, nor of the works which have been made, because there is no storage, and the canals are too small to deliver the quantity required *within the time limit*. The duty a canal can perform is the irrigation it can do within the first 30 days.

When it is found that these measures are not enough, then it will be advisable to think of making other storage tanks.

In the afternoon (10th February) went with the State Engineer and the Nazim to see a site between the villages of Sasoun and Bourikhera, about 1 mile north-east of Baran, where a storage reservoir might be made. There is good sand-stone rock visible in many parts, and apparently everywhere a few feet below the surface. The land is at present all waste. It looks as if a good reservoir might be formed here, by taking a bund from the village of Susoun, which would be at the west-end of it, along the watershed, between this nullah and the one on the west, in a northerly direction, as far as the fairweather road to Kishenganj, then eastward in the direction of Bourikhera.

Probably it might be filled from its own catchment. The nullah on the west might possibly be also diverted into it from some point higher up. If no better place can be found, then it remains to be seen whether it is possible to fill it from the Parbati Canal. This is very necessary, so as to make sure of a full supply every year in any case. Whether it will be possible to do this and to make a storage reservoir here large enough to contain about 500 m.c.ft. remains to be seen. It is worth while having plans and estimates prepared to ascertain these points. If water in sufficient quantity can be stored here, then a good large canal might be taken from it, to irrigate the Mangrol district northwards, and there is no doubt that it would be a very good project.

APPENDIX XIII.

Statement of Irrigation Works in the Kotah State, showing their cost, income up to 1959, and maintenance charges, &c.

Name of Project.	Cost of Construction.	Sambat.	Total Land irrigated.	Gross Income.	Maintenance charges.	Net receipts.	Percentage of Profit on outlay.	Remarks.
	Rs.		Bighas.					
Parbati Canal,	3,10,547	1945	5,755	7,641	4,351	3,293	...	
	...	1946	7,155	5,843	4,951	892		
		1947	12,959	12,794	4,707	8,087		
		1948	17,707	16,749	4,784	11,965	...	This year more irrigation owing to the dry season.
		1949	8,065	9,456	4,327	5,129		
		1950	5,143	4,053	4,820	767	...	Loss.
		1951	5,138	4,117	5,123	1,011		
		1952	9,309	9,777	5,620	4,157		
		1953	1,2853	20,806	3,618	17,188		
		1954	16,137	19,463	3,729	15,734	5·06	
		1955	13,702	16,897	4,332	12,565	4·4	
		1956	8,055	16,975	3,314	13,661	4·38	
		1957	8,369	15,032	3,205	11,827	3·80	
		1958	10,404	12,506	3,063	9,438	3 04	
		1959	...	...	...	...		
Iklera Sagar.	79,057	1945	905	1,125	...	1,125		
		1946	592	732	2,222	1,490	...	Loss.
		1947	862	1,014	217	797		
		1948	1,191	1,149	265	884		
		1949	1,140	1,141	580	561		
		1950	960	1,184	596	608		
		1951	753	1,224	665	559		
		1952	1,071	1,563	890	673		
		1953	1,746	3,574	453	3,121		
		1954	1,438	2,894	501	2,393	3·02	
		1955	1,007	1,873	504	1,369	1·73	
		1956	4,419	20,124	515	19,609	24·81	
		1958	1,205	2,557	462	2,095	2·63	
		1959	1,703	3,164	467	2,697	3 42	
Ramgarh Canal.	28,520	1945	...	...	...	...	...	The Canal was not ready in this year.
		1946	330	116	...	116		
		1947	615	710	322	388		
		1948	565	563	...	563		
		1949	624	606	...	606		
		1950	666	609	396	213		
		1951	467	690	302	388		
		1952	618	899	392	507		
		1953	977	1,334	268	1,066		
		1954	942	1,170	292	878	3·0C	
		1955	552	1,071	332	739	2·58	
		1956	6,733	2,822	374	2,448	8·58	
		1957	607	1,299	145	1,154	4·04	
		1958	596	708	239	469	1·64	
		1959	...	...	...	...	...	
Durrah, Minoda, Saraus	25,952	1945	968	370	..	370		
		1946	927	658	...	658		
		1947	2,299	1,398	354	1,044		
		1948	925	1,187	286	901		
		1949	988	1,340	286	1,054		
		1950	988	1,164	317	847		
		1951	776	1,362	563	799		
		1952	558	1,008	782	226		
		1953	608	1,141	785	356		
		1954	571	1,240	401	839	3·22	
		1955	562	1,055	553	502	2·00	

APPENDIX XIII.—(*Contd.*)

Name of Project.	Cost of Construction.	Sabmat.	Total Land irrigated.	Gross Income	Maintenance charges.	Net receipts.	Percentage of Profit on outlay.	Remarks.
	Rs.		Bighas.					
		1956	533	1 102	538	564	2.09	
		1957	516	757	467	290	1·11	
		1958	673	963	442	521	2 07	
Bilasara Tank,	6,217	1945	9	49	...	49	...	Not cultivated.
		1946	...	...	...	...	...	
		1947	10	57	322	265	...	Loss.
		1948	14	88	...	88	...	
		1949	...	...	...	...	...	
		1950	24	93	...	93	...	
		1951	23	102	...	102		
		1952	23	58	...	58		
		1953	20	71	11	60		
		1954	22	52	22	33	0·46	
		1955-57	...	...	...	..		
		1958	18	63	18	45	0 72	
Ayani Tank,	24,460	1945-52	...	...	...	...	...	Made in 1946 no profit up to 1952.
		1953	705	1,566	233	1,333		
		1954	819	1,689	160	1,529	6·16	
		1955	7	103	24	79		
		1956	...	...	132	132	...	Loss.
		1957	...	...	76	76	...	Loss.
		1958	283	330	144	186	0·75	
Jaloda Tejajee's Tank,	9,404	1945-52	...	...	...	...	...	Made in 1947 no profit up to 1952.
		1953	112	164	64	100		
		1954	48	141	58	83	·88	
		1955	...	. .	...	...		
		1956	228	479	60	419	4·47	
		1957	64	221	60	161	1·69	
		1958	146	417	59	358	3·80	
Dugade Tank,	9,762	1945-52	...	. .	...	. .	...	Made in 1943 no profit up to 1952.
		1953	12	20	..	20		
		1954	8	7	...	7	·07	
		1955	5	5	...	5		
		1956	14	78	5	73	·76	
		1957	4	42	10	32	·32	
		1958	75	94	14	80	·82	
Palai Tank...	4,927	1945 to 1952	...	...	. .	...	...	
		1953	59	61	...	61		
		1954	63	63	36	27	·54	
		1955	67	73	10	63	...	
		1956	123	554	10	544	11·14	
		1957	74	312	35	277	5·62	
		1958	69	298	38	260	5·27	
Barmori Saraw,	...	1945-46	...	...	...	...	...	Land tax not recovered not cultivated.
		1947	31	39	...	39	...	
		1948	22	31	...	68		
		1949	42	68	...	68		
		1950	15	37	...	37		
		1951	21	52	...	52		
		1952	2	5	...	...	5	Most of the cultivators of this village fled away.
		1953 to 1959	...	...	...	...	...	

APPENDIX XIV.

Statement showing the Pewat (land irrigated by well water) and Korwan (unirrigated) area of land in the Kotah State for Sambat 1955, or A.D. 1899.

No.	Name of Nizamat.	"Pewat" Irrigated land by water of well.	"Korwan" Unirrigated land.	Total Area.	Remarks.
		Bighas.	Bighas.	Bighas.	
1	Antah	55,191	1,11,061	1,66,852	
2	Baran ...	5,688	1,14,427	1,20,115	
3	Barod	1,138	91,883	93,021	
4	Digod	2,017	1,09,966	1,11,983	
5	Etawah	1,741	1,06,719	1,08,460	
6	Ghatoli	5,956	43,124	49,080	
7	Kanwas	4,788	82,210	86,998	
8	Kishenganj	3,030	41,826	44,856	
9	Khanpur	6,616	79,805	86,421	
10	Kunjer	4191	82,276	86,467	
11	Ladhpura	4,496	84,007	88.503	
12	Mangrole	4,659	96,201	1,00,860	
13	Sangod	4,829	94,885	99,714	
14	Shergarh	5,486	77,309	82,795	
15	Taraj	5,893	58,358	64,251	
16	Nahergurh	1,360	16,622	7,982	
	Total ...	1,17,079	12,91,279	14,08,358	

APPENDIX XV.

Statement showing Area irrigated by Iklera Sagar, during the last 10 years—from Sambat 1946 to 1955 (A.D. 1891-1899).

No	Name of Villages	Areas Irrigated and the Returns during the first 5 years, Sambat 1946 to 1950			Areas Irrigated and the Returns during the last 5 years from Sambat 51 to 55.		
		Cultivated Area.	Amount.	Irrigated Area.	Cultivated Area.	Amount.	Irrigated Area.
		Bighas.	Rs.	Bighas.	Bighas.	Rs	Bighas.
1	Iklera	1,465	2,645	369	1,085	1,957	349
2	Iodana	4,134	8,544	698	3,281	7,065	772
3	Gumanpura	2,031	4,488	514	2,812	5,478	965
4	Pipalda	1,992	4,625	260	2,536	5,337	500
5	Chinode	3,996	8,483	501	4,193	8,284	418
6	Digod Pir	10 960	21,015	1,558	10,019	19,284	2,022
	Total ...	24,578	49,800	3,900	23,926	47,405	5,116

APPENDIX XVI.

Statement showing Area Irrigated by Parbati Canal.

No.	Name of Nizamat.	Name of Village.	Area.			Area Irrigated by the Canal out of column No. 4.	Remarks.
			Cultivated.	Uncultivated.	Total.		
1	2	3	4	5	6	7	8
			Bighas.	Bighas.			
1	Kunjer,	Patatia Jagir ...	300	1,200	1,500	...	
2	„	Piplode ...	2,398	3,739	6,137	...	
3	„	Amia ...	177	980	1,157	5	
4	„	Kora ...	431	1,854	2,285	289	
5	„	Daingni Jagir ...	2,000	1,000	3,000	...	Estimated.
6	„	Dabri Jagir ...	1,500	500	2,000	...	Estimated.
7	„	Mundla ..	1,000	2,561	3,561	...	The Canal cannot reach through the area of the whole village.
8	„	Ramnawas ...	35	1,599	1,634	18	
9	„	Rutlai (Jagir) ...	4,000	1,000	5,000	...	Estimated.
10	„	Bamanhera ...	829	524	1,353	27	
11	„	Karmahera ...	1,459	1,153	2,612	468	
12	„	Loharia (Jagir)...	2,000	5,000	7,000	...	Estimated.
13	„	Hikar ...	1,099	1,324	2,423	648	
14	„	Kotra ..	1,000	500	1,500	...	Estimated.
15	„	Kotri ...	2,248	1,409	3,657	108	
16	Baran...	Mandla ...	1,500	8,314	9,814	...	The Canal cannot reach through the area of the whole village.
17	„	Lachmipura ...	650	1,005	1,655	...	Do.
18	„	Patora Jagir ...	3,206	1,689	4,895	409	Estimated.
19	„	Kedahori Jagir...	2,000	500	2,500	...	
20	„	Ankhera Jagir. .	1,300	200	1,500	...	
21	„	Jalera ..	732	2,049	2,781	68	
22	„	Narhera Jagir ...	1,650	165	1,815	..	
23	„	Bowrikhera ..	2,337	700	3,043	260	
24	„	Raptwan ...	201	380	581	74	
25	„	Gheesri .	919	1,246	2,165	444	Firstly the Canal was constructed 17 miles long, which is finished here from its head works.
26	„	Chandarpura ...	328	380	708	194	
27	„	Kalyanpura ...	614	1,429	2,043	239	
28	„	Susawan ...	1,835	2,376	4,011	121	Do.
29	„	Fatehpore ...	5,571	2,310	7,881	3,257	
30	„	Nayana ...	1,997	784	2,781	341	Do.
31	„	Sumalpur ...	553	737	1,290	327	
32	„	Ravoti ...	1,355	3,142	4,497	357	
33	„	Munthora ...	3,303	803	4,106	774	
34	„	Munthra or Pitampura.	3,000	1,015	4,015	1,716	
35	„	Sisaya Jagir ..	3,030	518	3,548	130	
36	„	Kali Baddin ...	1,688	1,140	2,828	144	
37	„	Bad Sai ...	2,230	1,084	3,314	1,401	
38	„	Miara ...	4,220	3,343	7,563	594	
39	Mangrole,	Both ...	6,382	3,391	9,773	1,928	
40	„	Barpura or Bhagwanpura.	1,115	3,165	4,280	154	
41	„	Jharoya ...	994	2,489	3,483	417	
42	„	Ausarpura ...	3,361	547	3,908	752	
43	„	Bhutwara ...	3,474	2,310	5,784	40	
44	„	Paolia ...	2,783	1,911	4,694	...	
45	„	Sodonia ...	871	326	1,197	...	
46	„	Chital heri ...	664	764	1,428	72	
47	„	Moradia ...	605	1,798	2,403	...	
48	„	Jarawad ...	443	924	1,367	...	
49	„	Milpura ...	946	1,424	2,370	...	
50	„	Khanpur ...	868	463	1,331	...	
51	„	Maoo ...	2,914	3,067	5,981	533	The length of the Canal from the Head works is 45 miles.
52	„	Mangrole (town),	8,694	5,068	13,762	...	
		Total ...	98,609	82,805	181,414	16,409	

APPENDIX XVII.

Summary of replies from 12 Nizamats giving reasons why more Irrigation is not done from existing tanks.

Serial No.	Name of Nizamat.	Serial No. of Tanks.	Name of Tanks.	Irrigation.		Remarks.
				Done.	Not done.	
1	Antah	1	Kachri... ...	...	No	Water dries up in summer.
2	Ladpura ...	2	Raipura or Rampura.	...	„	Owing to the excess of rain dam is broken, and so the water does not stay.
		3	Panchpahar ...	Yes	„	Dam broken so the water escapes.
		4	Rajpura ...	...	„	Water leaks out.
3	Digod	5	Amarpura ...	...	„	Do. lasts only for four months during the rains.
		6	Police (small) ...	Yes	...	.....
		7	Burgo	...	...	Not worth irrigation.
		8	Kasimpura ...	Yes	...	.....
		9	Digod	„	...	Not much, as the Zemindars do not use its water for reasons given in para. 26 (4)
4	Etawah ...	10	Ayani	Yes	...	2 or 3 villages are watered by it.
5	Baran	11	Kalmanda ...	...	No	Insufficiency and water not lasting for 12 months.
		12	Thoisar ...	...	„	Do.
6	Taraj	13	Bagair... ...	...	...	Useful only for retaining the water in the wells near and about.
		14	Gordhanpura ...	Yes	...	When it keeps up water.
		15	Kheri Borar ...	...	No	Does not retain water.
7	Barod	16	Jatoli	...	„	No sluice.
8	Kunjair ...	17	Sirode	Yes.	..	.....
9	Khanpur ...	18	Jolpa	...	No	Water does not stay.
		19	Bilasara ...	10 or 12 bighas	...	Water does not reach regularly as the sluice is built lower down.
10	Kishenganj ...	20	Bilas Canal ...	...	...	Not yet ready.
		21	Barlai	Yes	...	.....
		22	Kanwaria ...	...	No	Not enough water
		23	Bhanwargarh ...	80 bighas	...	.....
		24	Digodpar ...	1 field	...	On account of the Iklera Canal they do not take much water from it.
		25	Saran Bamoril...	...	...	Broken bund.
11	Mangrole ...	26	Jalora ..	Yes 300 bighas	...	So far as the canal is able to supply water.
		27	Chandraheri ...	...	No	Not enough water.
		28	Bal-Bamorel ...	No		Has no sluice.
		29	Another tank south of the village.	...	„	Do.
12	Sangode ..	30	Mandup tank ...	...	„	Insufficient quantity of water, dries up.

APPENDIX XVIII.

List of 27 works out of the total number of 67 entered in Appendix E, in the State Engineer's Report and proposed by the Revenue Superintendent, Kotah, in whose opinion they would be protective against famine. (Vide para. 21 of his Note).

No.	Name of Work.	Nizamat.	Estimated Cost.	Remarks.
			Rs.	
1	Lodha tank ...	Mangrole...	60,000	Would be profitable in famine years only.
2	Budaulit tank ...	Barode ..	90,000	do. do.
3	Tisoin ...	Mangrole..	45,000	do. do.
4	Anna Sagar feeder drain	Shahabad...	2,000	Repairs of the old tank necessary.
5	Shahabad Sarun	do.	12,000	The work which is in ruins, may be restored after consulting the Cultivators.
6	Simlod tank ...	Nahargarh ..	20,000	Although there are few Cultivators living near the tank, the tank would be very profitable.
7	Tarikhera tank	Antah ..	45,000	Would be profitable in famine years only.
8	Maoosa tank ...	Lalpura ..	60,000	The tank would give a fair profit in famine years.
9	Arlia tank ...	do. ...	36,000	Would be profitable in famine years only.
10	Bardla tank ...	Kanwas ...	30,000	Although the land near the tank is strong, it would be useful in famine years for lands not situated very far.
11	Shampura ...	Sangod ...	45,000	Would be profitable in famine years only.
12	Sameria tank ...	Kanwas ...	30,000	do. do.
13	Antralia tank ...	Suket ...	17,000	A profitable Project.
14	Kali Sindh canal	Kanwas ...	3,00,000	In the time of the late Mr. Miles, proposals were made to bring a canal from the village Khanpur, and tracings, &c., on the map were made, but as it did not appear a profitable scheme, no recommendations were made to construct it. The whole water of the canal will not be consumed within 22 miles, to which length the canals are for the present, proposed to be extended. The length of the canal will have to be increased and the estimates revised. *Kharif* will not require irrigation till November. Irrigation will commence from December, but it will give little profit. The canal will certainly be a great protection against famine.
15	Maonjar tank ...	Taroj ...	2,50,000	Munfi villages are situated at the commencement of the river, and next to them are the Khalsa villages. A handsome profit cannot be expected every year. It will, of course, be profitable in a famine year.

APPENDIX XVIII.—(*contd.*)

No.	Name of Work.	Nizamat.	Estimated Cost.	Remarks.
			Rs.	
16	Parwan tank ...	Shergarh ...	3,00,000	To construct a tank in the natural bed of the river by damming its flow would be to incur a great danger. It will be safer to fill one or two tanks (to be constructed at some distance from the natural bed of the river), by means of canals cut from the river. The survey of this project was made by the Revenue Superintendent himself in the time of the late Mr. Miles, and tracings, &c. on the maps, which were with him, were made. Although it would yield but little profit in ordinary years, it would be very beneficial to the people and the State in famine years.
17	Ramgarh tank...	Kishenganj,	60,000	Catchment area 12 miles, capacity 150 m. c. ft.; surplus water of the Ramgarh Canal will also fall into this tank, which commands 5 villages, the whole of which require irrigation. The work would yield a profit of 3 or 4 per cent.
18	Sumrania tank...	Kelwara ..	40,000	Catchment area 8 miles, capacity 200 miles cubic feet. In this country water of tanks constructed in the beds of nullahs is very soon absorbed. It is therefore proposed to construct the tank on black soil (where less water will be lost in the ground), at a distance of 1½ miles from the nullah, so as to avoid the stony ground. The rain water contained in the nullah will be diverted into the tank. The work will certainly give a profit of 3 or 4 per cent.
19	A Tank near Baran below the Parbati Canal.	Baran ...	1,10,000	Plan and other papers showing capacity of the tank are in the State Engineer's Office. The tank will be filled by a nullah and by the surplus water of the Parbati Canal, and will be replenished till December of every year by the canal water. The level of the Parbati Canal near the tank being low, the tank water can be easily carried to a distance of 20 miles in the Mangrole Nizamat, and after the canal is closed the tank would irrigate sugar-cane in the summer seasons. It will be of great benefit in years of famine.

APPENDIX XVIII.—(*concld*).

No.	Name of Work.	Nizamat.	Estimated Cost.	Remarks.
			Rs.	
20	Raipura tank ...	Ladpura ..	5,000	By repairing the tank 700 bighas more of land will be irrigated. The catchment area of the tank will also be enlarged.
21	Dhonia tank ...	Ghotob ...	12,000	One of the wings of the old tank which must have cost Rs. 40,000 is in a broken condition. By repairing the broken wing a large and deep tank will irrigate the waste land and it is hoped that a new village will be formed near it.
22	Belkheri tank ...	do. ..	10,000	A fine site for a new tank, would irrigate 3 or 4 villages. Lands require irrigation.
23	Harigarh ...	Taraj ...	9,000	Repairs to an old and broken tank. All lands surrounding it require irrigation.
24	Madhopura ..	do. ...	10,000	A good deal of culturable land is lying waste for want of water. If a tank be constructed here, the land will be brought under cultivation and a new village formed.
25	Cavalization of village streams and brooks.	All Nizamats of the Kotah State.	1,60,000	Where there are no wells for poppy irrigation it would be profitable to dam Nullahs and to cultivate poppy on both sides of the canals. This point has been dealt with in clause B, of para. 18 of Note of the Revenue Supt. The total cost of the work at Rs. 10,000 for each Nizamat is estimated at Rs. 1,60,000.
26	Small bunds to divert Stream and Nullah courses.	16 Nizamats,	48,000	This has been dealt with in clause D, of para. 18 of Note of the Revenue Supt.
27	Increasing the height of the "Bund" of the Parbati Canal at its Head works.	Kunjer ...	30,000	In order to collect a sufficient quantity of water for opium, irrigated till the end of the season, temporary Kutcha bunds of an height of 1 foot are constructed every year on the permanent masonry bund of the canal.
	Grand Total...	...	18,36,000	